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The Superiority of Ford's Education

A few years ago Henry Ford sued a newspaper for libel because it had called him an "ignoramus" and other belittling names. In the trial the attorneys for the newspaper asked Ford many questions relating to American history, which Ford could not answer; and in his defense Ford made the widely quoted reply that "History is bunk." Whereupon newspaper editors from Portland to Portland had their laughs at Ford. And who doesn't like to smile at the assumed inferiority of any great man? It so tickles one's vanity to feel greater than the great.

Yet one of the greatest philosophers that ever lived, Herbert Spencer, had said almost the same thing—"history is bunk"—and he had said it in an essay on education that is even yet read (but not remembered) by most pedagogs. Spencer said that the mere learning of facts is of no importance unless they are facts that are to be put to use. A fact it is that my neighbor's cat had kittens yesterday, and just about as usable a fact as the chronology of England's kings, said Spencer. "Men dress their children's minds as they do their bodies, in the prevailing fashion, he added, and it is fashionable to know history and belles lettres. Then he contrasted the usableness of historical facts with scientific facts. The one class of facts are the ornaments of knowledge, the other class are the tools of knowledge. Which do you choose, he asks, to be gabby in history or successful in earning a livelihood and in preserving your health and that of your family?

Ford may never have read Spencer, but he certainly has followed Spencer's injunction, for his life has been one of scientific investigation and the application of the knowledge thus acquired. Read his biography if you doubt it.

Had Ford been able to cross-examine his cross-examiners in that celebrated libel suit, all he need have done to disclose their poverty of knowledge would have been to hand them one of Edison's questionnaires. You remember their character? A long list of scientific and semi-scientific queries that not one lawyer in a thousand could answer sufficiently well to get into a scientific kindergarten. Now who was the real ignoramus? Ford or the lawyer cross-examining him? The one, unknown to the world, the other known wherever modern machinery exists. The one, making a living by appeals to juries, the other making the greatest fortune ever accumulated, and in doing so, employing armies of men at the highest wages ever paid for similar work?

But some will reply, education is a school training whose object is to give breadth of culture. Would you give up such an aim for mere utilitarianism? Yes, we would. Breadth of culture? Who ever got it in any school, save the school in which each man is his own teacher? Breadth of knowledge must be a part of breadth of culture. Yet what breadth of knowledge does any school give you? Look over the score of books that you mastered in high school, and the two score that you mastered in college. Then go into any large library and walk for hours through the serried ranks of volumes—a million or more—asking yourself every few steps, what do my 60 school books contain compared with this million? Was the knowledge gained from the 60 broad? As broad as a drop of rain is to the globe toward which it falls.

So, breadth of knowledge can not be derived by study of the few text books of school and college. Can breadth of experience be thus acquired? Obviously not. What then is acquired by formal education under teachers that can be said to be truly broad? A breadth that is so far reaching that it enables a man greatly to surpass those who have it not? Just one thing: The training that makes a man a systematic searcher for usable facts and gives him skill in using the facts. Edison who had but meager schooling, attained such a breadth. Lincoln, with even less schooling, got it. Ford has it. Every great succeeder has had it.

We hear it argued that such great men need no teachers. Their genius makes them great. We don't believe it. Their teachers have been, first, the writers whom they have studied, and, second, Nature, whom they have interrogated. Nature includes, of course, all animate and inanimate things, and she speaks with a million tongues, if we but pause to interrogate her. Most of us never learn to ask her questions. A few do, and they become the discoverers. But at least we should be interested enough to ask those discoverers what they have discovered, yet few of us do.

So we conclude that the appalling ignorance of school trained men in general is evidence that their schooling failed to give them "breadth." Yet because they can still tell who Benedict Arnold was—well, that, sort of thing, in their opinion, makes them broad.

H. P. Gillette

Roads and Streets Absorbs Road and Street News

Road and Street News, a free-circulation magazine supplement to Roads and Streets, has been in existence 5 years. It now ceases to exist, and the sample copies of Roads and Streets take its place.

The gross circulation of Roads and Streets will be 27,000 copies, of which half represent net paid subscriptions. The paid circulation of Roads and Streets has had a phenomenal growth, and no let up is yet in sight. It will surely exceed 15,000 before the frost is out of the ground, and is likely to be 18,000 when another January rolls around.

Roads and Streets, for many years past, has had a larger paid circulation in the highway field than any other magazine, but we have not been satisfied with that fact, for the highway field is the largest specialized construction field other than that of buildings, and in it are fully 40,000 men in engineering and executive positions. From these 40,000 we selected 27,000 as holding the most important positions relating to the construction and maintenance of roads and streets. Of these 27,000 we now have induced 50 per cent to become paid subscribers, and we are confident that the percentage will approximate 66 within a year. This confidence springs from the pronounced success of our recent subscription campaigns.

More and more is it becoming evident that men must read in order to broaden their experience, for what one reads and absorbs becomes truly one's own experience if we mean by experience knowledge gained through any channel whatsoever. What does it matter whether you have learned a principle or fact by personal observation or by reading, so long as you have such a clear conception of it that you can use it in your profession or business? One of the persisting mistakes in training young men is in not habituating them to seek, systematically, for usable knowledge in books and periodicals. Here and there a few men become so trained (usually self-trained) and from among them develop the leaders in science and industry. On this point we refer the reader to the editorial article on Ford's education.

The Most Important Profession

Training the young mentally and physically is perhaps the most important of occupations, yet teachers are badly underpaid. Herbert Spencer would tell us that the primary reason that teachers are underpaid is because they are employed by the public, and that the public is notoriously a poor employer. He would doubtless still advocate the return to private schools, and would point to ancient Greece where one of the highest paid professions was that of teaching. In those early days when science was born, Prof. Aristotle and Prof. Archimedes were not only the most celebrated of Greeks but were among the wealtiest. Their classes were filled with students ambitious to learn the secrets of their ability, and their fees as teachers were proportionate to their reputation as thinkers.

Suppose some Rockefeller were to organize a research college and were to employ such men as Edison and the late Luther Burbank as teachers, and were to charge tuition fees that would make the institution not only self-supporting but profitable. Can it be doubted that thousands of parents would send their sons to learn from such geniuses the methods by which their inventions and discoveries were made?

Carnegie thought he was rendering a very great service to humanity when he endowed free libraries; and it was a great service, but it might have been vastly greater had he organized a library company that charged a fee for the use of its books. Then by advertising the wealth of information on its shelves—even as gum and automobiles are advertised—and by showing the public that knowledge is not only power, but its possession a pleasure beyond most others, the Carnegie libraries might have become hives of knowledge seeking men and women, whereas today they now resemble tombs in which mummied knowledge lies in undisturbed and dusty repose.

It is not enough to acquire and to publish knowledge. It must be advertised so that desire for it shall become universal. But advertising is one of the arts that governments have never learned and probably never will. Here and there a Prof. Millikan has secured enough free publicity to attract students, but more than such scattered and unorganized advertising is needed, if scientific education is to become greatly desired.

Dr. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching, has expressed doubt that better teachers would be secured if teachers' salaries were raised. He says that their salaries have increased fully one-third more than the cost of living has increased since 1913 and he argues that teachers enter their calling because they like the work, and that higher salaries would not attract better teachers. Of course he has to admit that teachers themselves disagree with him. And we think that he would have to admit also that experienced employers the world over would disagree with him. Large remuneration is a magnet that attracts brains everywhere. Only one other magnet compares with it in power, and that is the magnet called fame. But few American teachers see either great income or great fame at the end of the rainbow.

In the lower grades of our schools almost all the teachers are women. This is so because their salaries are too small to attract many men. Yet it is universally admitted that boys should come early under the influence of men teachers.

In the higher grades, ambition can best be aroused by teachers who are famous for their originality. And where are they? A scattered few. Yet few they are not because originality is rare but because its rewards for teaching are meager.

The greatest of professions, teaching, is sorely in need of stimulation. Will the stimulus come at last from a public awakening to the importance of securing the best teaching talent, or will it come from a great revival of private teaching by men of genius for profit?

One Course Concrete Pavement Constructed With Sand-Gravel Aggregate

Sand and Gravel Pumped from Little Arkansas River for Road Job in Kansas County

General View of Local Plant for Producing Sand-Gravel

Sedgwick County, Kansas, is located in the south central part of the state in the valley of the Arkansas River. The surface geological formation is sandy and there is no coarse aggregate available locally, which is suitable for concrete pavement. The nearest available supply is a washed gravel from Douglas, Kan., with a freight haul of 4 c. per cwt. During a busy season this one source of supply cannot meet the demand and as a last resort, coarse aggregates are shipped from Missouri and Oklahoma with freight rates of 11 and 14 c. per cwt.

The Local Aggregate Supply.—The Arkansas River crosses Sedgwick County on a diagonal from the northwest to the southeast. The bed of this stream is sand for a depth of 30 to 45 ft., which is well graded from fine to coarse and has a fineness modulus of about 3.0, which can be increased to about 4.0 by screening out the finer material. The Little Arkansas River enters Sedgwick County from the north and empties into the Arkansas River at Wichita, near the center of the the county. The bed of this stream is sand for a depth of 25 to 30 ft., the sand having a fineness modulus of 3.6 which can be increased to 4.25 by screening out the finer material, without making a harsh mixture.

Excellent results were obtained with pit-run material from the Little Arkansas River and with graded sand from the Arkansas River in constructing the concrete base for 12 miles of brick road, suggesting the possibility of using this material for one course concrete pavement.

Control of Sand—Graded Aggregates.—Tests carried out in the Road Materials Laboratory of the Kansas State Agricultural College developed the following specification for controlling the grading of sand-gravel aggregates for one course concrete pavement:

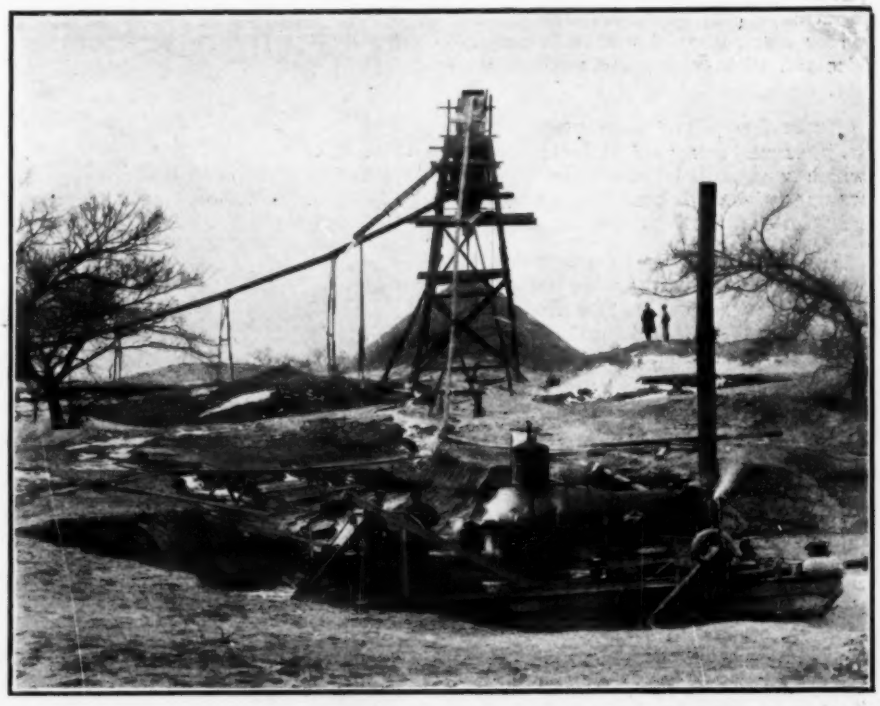
Retained on a No. 4 sieve not less than 10% nor more than 25%.
Retained on a No. 8 sieve not less than 35% nor more than 50%.
Retained on a No. 28 sieve not less than 75% nor more than 90%.

A specification was written to permit the use of material meeting the above requirements, the mix being specified as one part of cement to 3¾ parts, dry and rodded, sand-gravel aggregates, with a minimum cement content of 1.8 bbl. per cubic yard of finished concrete and also a minimum required compression strength of 2,000 lb. per square inch at seven days and 3,000 lb. at 28 days. This specification was made optional with the contractor when bids were advertised for the construction of 5 miles of 18 ft. Bates type concrete pavement on State Highway No. 96, F. A. P. No. 342, which enters Wichita, Kan., from the northwest.

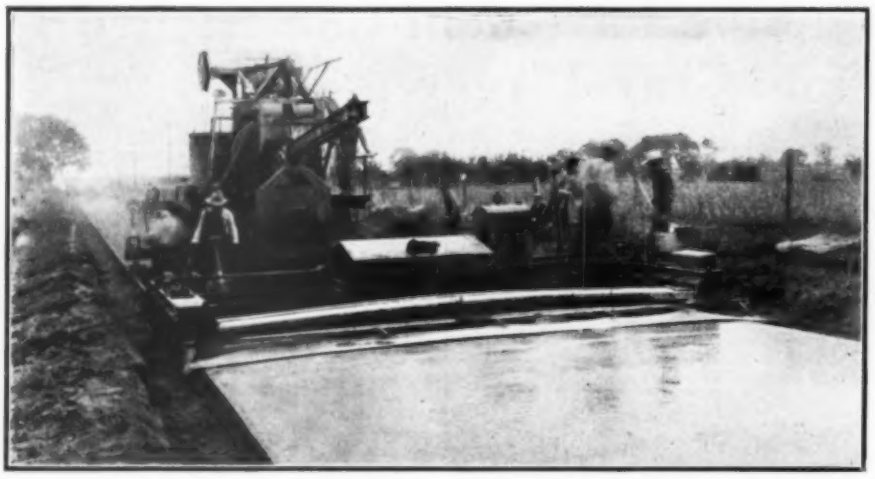
Bids were opened Sept. 2, 1926, on this project and the Shultz Construction Co. of Wichita, Kan., submitted a bid of $1.74 per square yard for 9 in.-6 in.-9 in., 18 ft. concrete pavement with reinforcing steel and center joint. The reinforcing consists of two ¾ in. longitudinal bars, two ¾ in. transverse bars at each expansion joint and 4 ft.-½ in. round bars at 5 ft. centers through the center joint.

The Arkansas River crosses this project and the Little Arkansas River is one mile from the beginning of the project. Borings showed that material meeting the proposed specification could be produced from the Arkansas River by rejecting the fines and that very little material would have to be wasted to produce the required grading with material from the Little Arkansas River.

The Aggregate Production Plant.—The contractor decided to produce the aggregate from the Little Arkansas River. A 6 in. centrifugal pump, driven by a steam engine mounted on a barge, was used to pump the sand-gravel from the bed of the river. A



Pump on Barge in Old River Bed; Line to Tipple and Grade



Finishing Maize Road in Sedgwick County, Kansas

water grading device was used to reject enough of the finer material to bring the sand within the required specification. The pump was operated during seasonable weather in the winter of 1926-1927, and practically all of the material was stock piled before paving operations were started.

Paving Equipment.—The paving equipment consisted of a clamshell bucket attached to a Keystone excavator for charging the batching bin to which was attached a Johnson weighing batcher; a Hug subgrader, Rex 27-E paver, Ord finishing machine, steel side forms and a Barnes triplex pump. Trucks were hired to haul at so much per load-mile.

Forty working days were required to complete the 5 miles of pavement which is an average of 666 lin. ft. of 18 ft. pavement per 8-hour day. The maximum day's run was 1,004 lin. ft. The mixer was equipped with a timing device and all batches were mixed a minute.

Expansion joints were made at 150 ft. intervals, using a 2 in. header board, which was pulled before the concrete was fully set. A plastic sand asphalt mixture was used to fill the joint.

The initial curing of the pavement was done by covering with burlap and sprinkling with water, and final curing by application of calcium chloride at the rate of two and one half pounds per square yard.

Close Control of Proportions.—For 24 of the 40 working days the actual cement used checked within less than 1 per cent of the calculated amount required, which shows the close control of proportions maintained by a weighing batcher. Any variations more than this could be traced to irregularities in the subgrade. The moisture in the aggregate stock pile did not vary more than 1 per cent which did not require any change in the proportions by weight to maintain the cement factor constant.

One 6 in. by 12 in. test cylinder was made for each 1,000 sq. yd. of pavement. Forty seven of these cylinders averaged 4,220 lb. per square inch compressive strength. Two specimens were less and three more than 15 per cent of the average. Two varied more than 20 per cent and all were above the required 3,000 lb. minimum.

The mixer was equipped with an accurate water measuring device, which combined with weighed aggregates, produces a concrete of uniform consistency. A very smooth riding surface was obtained, no variation of more than ¼ in. in 10 ft. being permitted.

The total contract price for this 5 mile project is $106,750.48 or $21,126.15 per mile, exclusive of drainage structures over 20 ft. span. The grading was done by the county at a cost of $1,000 per mile, making the total cost of an 18 ft. concrete pavement, $22,126.15 per mile, which is $13,000 per mile less than the average cost of 36 miles of concrete road previously built in Sedgwick County.

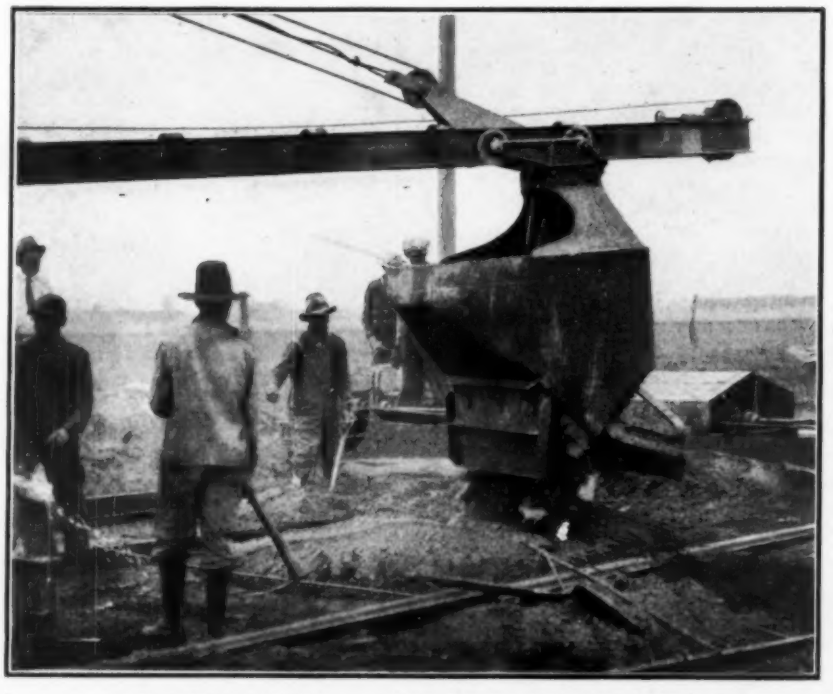
Amount of Surface Covered by Paint

The following table taken from the 1927 Construction Manual of the Ohio State Department of Highways shows the square feet of wood surface covered by 1 gal. of paint:

		Sq. Ft. Covered by Gal. Mixed Paint			
		Green Lumber		Seasoned Lumber	
Kind of Wood	Planed	Unplaned	Unplaned	Coat	Planed
Yellow Pine	1st	450	350	350	300
Yellow Pine	2nd	600	550	600	500
Yellow Pine	3rd	600	550	600	500
Oak	1st	450	350	350	300
Oak	2nd	600	550	600	500
Oak	3rd	600	550	600	500
Poplar	1st	400	350	375	300
Poplar	2nd	550	500	550	500
Poplar	3rd	600	550	600	550

In painting lattice work, figure on a gallon of paint covering about 100 per cent less wood surface than the square feet given above. In repainting, the quantities given the column for "Unplaned seasoned lumber" would be taken.

Road Construction in Quebec.—The Province of Quebec built 1,307 miles of roads during the 1927 season, which, according to the Minister of Roads, constitutes a record in the Province. Types of roads built and the length of each were: Gravel, 1,210 miles; soft roads, 63 miles; and macadam, 27 miles.



View Showing Consistency and Workability of Sand-Gravel Mix

Survey of Surface Treatment Field

Skin Surface Treatment, Mixed in Place Method and Premixed Method Described in Paper Presented Nov. 29 at 6th Annual Asphalt Paving Conference

By C. N. CONNER

Chairman, Low Cost Improved Roads Investigation Highway Research Board, Washington, D. C.

Looking back a number of years we find high type pavements have met the needs of thickly populated communities. During this time many rural sections have not been as fortunate. In fact it was not until after 1920 that appreciable mileages of low cost improved roads began to appear. These untreated surfaces were not expected to carry heavy traffic, but with improved methods of maintenance, reconstruction, betterments and new construction highway engineers have rapidly extended road service to these rural sections. The results of their efforts have been effective but they have not kept pace with the ever mounting vehicle registration. Just what has been accomplished and how it was done is a subject which I have found intensely interesting during a two years survey of low cost improved roads.

Motor Vehicles and Road Mileage. — Pyke Johnson says there are 22,000,000 motor vehicles in use in the United States, 87 percent passenger cars, 12.6 percent trucks and 0.4 percent busses. The task for the road builders is to give them highways to roll over. Our total road mileage is about 3,000,000 of which 85 percent are unsurfaced, 10 percent are a low type surfacing such as untreated sand-clay, gravel and stone; 4 percent are an intermediate type and less than 2 percent are high type surfaces. These figures indicate that a high percentage of our roads will need some type of surfacing or surface treatment within the next few years, if the now isolated sections are to have service.

Curves of motor vehicle registration are still pointing upward. For example right now there are several states south of the Ohio River and west of the Mississippi which need a large mileage of low cost surfaces and surface treatments. At least one of these has less than 10 miles of high type surface and no surface treatments. The North and South Atlantic states and a few Middle Western states have used surface treatments for at least a decade. It is only recently, however, that states with large areas and a comparatively small population have entered the surface treatment field.

Doubling Road Capacity by Surface Treatment.—There appears to be a tentative agreement among road builders that untreated sand-clay and gravels have a limitation of from 300 to 800 vehicles per day without excessive maintenance costs. Some states do not believe in surface treatments. They do not think the cost is justified and that the next upward step from an untreated gravel or sand-clay calls for a surface of the pavement type. Those who have inherited old macadams and stone roads are frequently willing to salvage them by adding a surface treatment. There is evidence, however, that not only macadam but also gravels and sand-clays can be satisfactorily surface treated and that their traffic capacity may be doubled at very much less than half the cost of the pavement type.

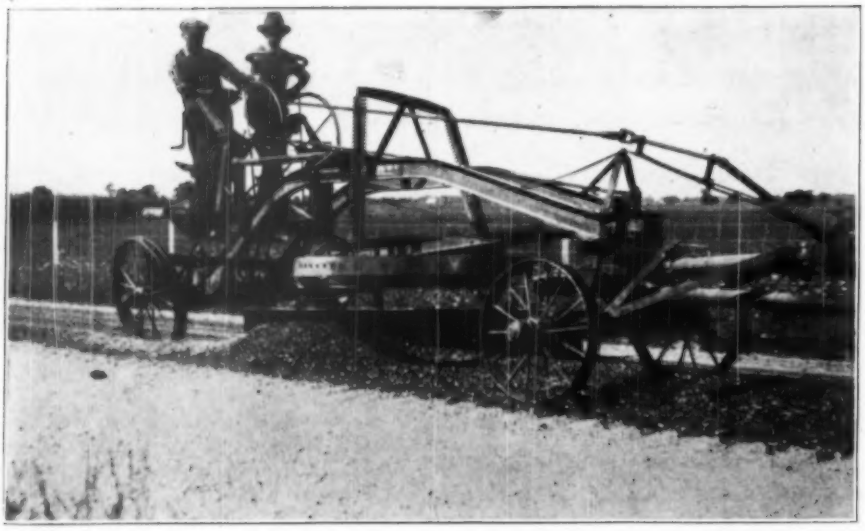
Peneration Method in Maine in 1927. Cold Tar Surface Treatments on Gravel. Application of Tar Followed Immediately by Cover Material of Sand

About 1920, when automobile registration began rapidly to increase, it was found that funds and time were lacking to give road service over a sufficient mileage to satisfy the public. The construction of high type roads required more time, more money and more detours than many portions of the country could divert to road building. There were conditions where the present and probable future traffic did not warrant so great an expenditure. By some engineers it was considered more important to connect objectives and build feeder roads to trunk lines with a roadway capable of taking traffic up to 1,500 vehicles per day. And so this new era of low cost road construction began. Today we find their ideas bearing fruit and an ever increasing interest in roads of this type.

Bituminous Surface Treatment. — There are two principal classes of surface treatments, bituminous and non-bituminous. Some non-bituminous surface treatments, have been used successfully in certain localities. The degree of success varies considerably with climatic conditions. Here today we are principally concerned with bituminous materials. The bituminous treatments are adaptable to varying conditions of climate and aggregate. Besides laying dust and preventing loss of binder they have a definite salvage value from year to year.

It has been said that a bituminous surface treatment is at its best during the first year of service. This was probably true until quite recently but some maintenance engineers are finding ways and means to refute this argument. How they do it is an interesting subject beyond the scope of this paper. Until about 1920 asphalts and asphaltic road oils were used primarily as dust layers, thin surface treatments and as binder for penetration macadams. There were some exceptions such as the road oil work in Long Island and a fair mileage of the city type of bituminous pavements or rural highways. This was the beginning.

Just now, as a result of very little research, some experiments but with a large amount of usage we find three principal methods of bituminous surface treatment. They are: (I) The Skin Surface Treatment or Penetration Method, Hot or Cold. (II) The Mixed in Place Treatment, Cold. (III) The



Mixing in Place Method. Mixing Bitumen (Cold) with Roadway Aggregate. After Thorough Mixing the Surface Is Finally Machined to a Smooth Surface. Compaction Is Obtained by Rolling or Traffic

Premixed Method, Hot or Cold. Each of these principal methods has its advocates and is subject to variations in the classes of bitumen and aggregates used. A brief description of each will be given.

Skin Surface Treatment or Penetration Method.—This method is generally used on well compacted dense bases which do not have a loose surface.

Materials.—The bituminous materials are a cold bitumen for the first, or prime, coat. Generally a cold tar, a cut-back asphalt or low viscosity road oil. The second application may be a second prime coat of the same bitumen. The seal coat is generally a heavier bitumen such as a hot asphalt, hot tar, a cold cut-back asphalt or a heavy road oil. The aggregates for cover material range all the way from a coarse clean sand to ¾ in. stone or slag. Cover material should be hard and durable.

Construction methods are simple and consist of: (1) Cleaning the base. (2) The application of a prime coat of low viscosity bitumen. (3) Ten hours to several days to allow penetration. (4) A second prime coat of the same bitumen may be advisable for the more porous bases. (5) A light cover may or may not be used on the prime coat. Better penetration results, when not used as the cover takes up some of the bitumen. Traffic requirements may make the cover necessary. (6) and (7) The last application of the heavier bitumen and cover of sand, gravel, stone or slag. The so called inverted penetration method means that the bitumen is applied before the final cover. The inverted method is the more common practice. (8) The surface thus formed may or may not be rolled. Best practice calls for rolling with a light or heavy power roller. A heavy roller should not be used on a relatively soft aggregate. (9) Seal coats or a third application are sometimes used to seal the surface if open or to build up a greater thickness.

Maintenance methods include retreatments, patching, scarifying, reshaping and retreating of the original surface treatments.

The cost of the first year's treatment will be considered as the original cost. This will naturally vary with the cost and class of materials used. Asphalts generally cost less than tars. Cut back asphalts cost more than road oils. Sand for cover costs less than stone. Annual scarifying, reshaping and light retreatments may add to the maintenance cost. A smoother riding surface is obtained than when a large number of small patches are used. The skin surface treatment for the first year as here described will cost from about $1,000 to $2,500 per mile for an 18 ft. width. The annual maintenance cost is subject to many variables of climate, materials, base, traffic, thoroughness and intelligence of maintenance. When serving within its traffic capacity the annual surface maintenance cost does not exceed $1,000 per year under unfavorable weather conditions. Under favorable weather conditions and on excellent bases the maintenance cost will not exceed $500.

The traffic capacity of this type under favorable conditions of base and climate is probably 2,000 vehicles per day, without excessive maintenance. Higher capacities have been reported. A fair average traffic capacity on gravels and top soils is from 800 to 1,500 automobiles and light trucks. A higher limit may be reached on lime rock or stone macadam bases. Examples of this type of surface may be found in use from Maine to Florida, in California and Oregon, and in portions of the Middle West.

The Mixed in Place Method, Cold.—This is a method that is new, within three or four years. Its purposes is to consolidate the existing loose or unstable aggregates by mixing them on the road with bitumen. Surfaces containing such aggregates as crushed or screened gravel, stone and sand clay or sand loam have been thus improved.

Either asphalt or tar have been used as bitumen. In a few instances both have been used. They range all the way from fuel oils as used in California to cut back asphalts in North and South Caroline and tars in Wisconsin. The bitumen should be such that it will not become sticky or "set up" until sufficient time has elapsed for the necessary manipulation of the mixture. The road oils which do not contain a solvent set up more slowly than the cut back asphalts. They also leave a more plastic mixture. The surfaces which contain such aggregates as crushed or screened gravel and crushed stone have generally been selected for treatment. There is evidence, however, that poorer materials such as sand clay may be thus sufficient stabilized and its traffic capacity increased.

Premixed Hot or Cold Method. The Bitumen and Aggregates Are Mixed at a Central Plant, Hauled, Spread and Rolled

Construction methods are briefly listed below and are subject to some variations in different parts of the country. (1) Smooth the existing surface. (2) Scarify if necessary, harrow, machine and shape. (3) Apply first coat of cold bitumen and mix with harrow and road machine blade. Sometime harrowing is omitted. Blading is seldom omitted. (4) Apply second coat of bitumen and mix thoroughly. (5) Sometimes a third coat is applied followed by more mixing. (6) Mixing is continued until a uniform color results. (7) Following a final shaping with a road blade or a drag the surface preferably is rolled for final compaction with a power roller. Some engineers secure compaction by traffic. (9) A seal coat may be used if needed. An open surface may indicate this necessity or a lean base may be the indication.

These surfaces are built as thin as about 1 in. and as thick as 3 in. Maintenance methods may include seal coats or patching with a mixture of aggregate and bitumen. If the original mixture was too lean, a remixing with more bitumen may be indicated; if too rich, a remixing with more aggregates may be the solution.

For an 18 ft. width of treatment the cost will range from $1,100 or $1,200 per mile to $5,000 or $6,000. The class of bitumens used as well as the depth of treatment will affect the cost. Most of the surfacing has been on gravels and stone roads. The first cost for these has averaged less than $2,000 per mile.

Some of these surfaces are carrying a counted traffic of between 1,000 and 2,000 vehicles per day without signs of serious fatigue. The surfaces are smooth and comfortable to ride upon, much smoother than the average skin surface treatment or rolled hot top. The mixed-in-place surfaces may be built without serious interruption to traffic and the inconvenience of heating operations. This type of surfacing may be seen in service, but with some variations in construction methods in California, Wisconsin, Indiana, Tennessee and North and South Carolina. Although the sand oil roads in Long Island are a mixture of fine gravel, sand and loam with a slow curing oil the foregoing construction methods do not apply as closely to them. The construction and maintenance operations eventually build up a mixed in place surface after two or three years.

The Premixed Method, Hot or Cold.—This class of surface treatment is in reality a thin surface course as we have been accustomed to consider surface or wearing courses, such as bituminous concrete and sheet asphalt. By laying them thinner than standard practice or by using local materials it is expected to secure a surface whose first cost is less than $12,000 or $15,000 per mile. Included in this classification are such hot mixes as sheet asphalt and bituminous concrete of the fine and coarse aggregate types. The laid-cold surfaces are cold-patch bitumens, cutback asphalts and road oils premixed with aggregates. Your association knows and engineers know that natural rock asphalts are a competing material within certain freight zones. They may also be classed as premixed cold surfaces.

For the hot mixtures standard specifications describe suitable bitumens and aggregates. The cold mixtures for surfacing are newer. Specifications for them are not as well standardized as a whole. Specifications for Amiesite and cold patch mixtures which may be used for surfacing are available, as are also those for Uvalde Rock Asphalt, Alabama Rock Asphalt and Kentucky Rock Asphalt. Some experimentation and a little usage indicate that there is a possibility of producing an "unnatural" or synthetic rock asphalt. That is, one which may have many of the characteristics of sand rock asphalt.

If the applied surface mixture is to be less than about 1½ in. in thickness and the base is porous or semi-porous then a prime coat of suitable cold asphalt or tar is recommended. A binder course of "black base" or a thin course of penetrated stone will add to the stability and assist in keying the top to the base. In one state, Michigan, both the prime coat and binder course are used on gravel base. The top course is stone filled sheet asphalt or fine aggregate type. The construction of the top itself varies very little from standard methods as found in The Asphalt Association Specifications. They include proper dumping, spreading, raking, patching and rolling. Final compaction by rolling must be secured in less time for the hot mixes than for the cold.

This class of surface treatment is generally maintained by patching with the same material as in the surface or by cold patch mixes.

The aim in this class of surfacing is to secure a surface which will cost less than $1.00 per square yard, or about $10,000 per mile of 18 ft. width. Rock asphalt has been laid in Texas for a ½ in. depth at $3,700 per mile, 1 in. for $5,400, including a prime coat of oil. In Michigan a prime coat of tar, a light binder course and a 2 in. "Topeka" top is costing around $13,000 per mile. Some work in Georgia using about 2 in. of penetrated stone and about ¾ in. sheet top cost approximately $12,000. When local materials may be used as aggregates the costs have been considerably reduced for the hot mixes. There is little cost or usage data available for hot or cold premixed surfaces one inch and less in thickness. Here and there are isolated sections but Texas seems to have the largest mileage of thin premixed surface treatments.

The traffic capacity of these types on substantial bases has been estimated and counted as between 1,000 and 2,000 vehicles per day. Some are carrying more. This type of surfacing is not as smooth to ride over as the mixed in place surfaces. The cold mixes have some apparent advantages over the hot mixes. This advantage is apparent principally during the construction period. There is less interruption to traffic, less expensive equipment is required, and cost of plant operation is reduced.

Summary.—As a summary of the surface treatment situation, based on observations of usage and a study of present practice and conditions, it appears, (1) That surface treatments should not be less than 18 or 20 ft. in width and preferably from shoulder to shoulder. (2) That flat crown of ⅜ to ½ in. to the foot are sufficient for drainage. Flat crowns add to the comfort and safety of automobile travel. (3) That a cold prime coat of bitumen should precede a bituminous surface treatment on a compacted base. (4) That a hot or cold treatment may be used as the final application. (5) That a surface treatment method which includes blading is smoother riding than one which is rolled only. (6) That cold surface treatments of the mixed-in-place and premixed methods offer a wide field for immediate and future business. (7) That there is a need for standardization of names for surface treatments; and of specifications for materials, tests and methods of construction.

The surface treatment field is continually changing in character and territory. Its character is being changed by improved quality of workmanship and methods. The territory is growing to include larger areas and new fields. In the future we shall see a great number of highway departments employing engineers of training and experience as supervisors and foremen, a closer contact between laboratory and field surface treatment work, and a greater amount of surface treatment work let to contract.

More Road Work in Idaho

Bannock county, Idaho, has agreed with the state department of public works on a program for 1928, involving the paving of five and a half miles of the Yellowstone highway south of Pocatello and the oiling of the remainder to the Franklin county line. Announcement to this effect was made recently by Joe D. Wood, commissioner of public works. The work will be done by the state and county in cooperation with federal aid funds supplied. Included in the job is the widening and resurfacing of eight miles near Virginia. The oiling treatment to be used is the same bituminous surfacing to be used on the Nampa-Boise highway, a method advocated for roads of exceptionally heavy traffic.

Roadside Tree Planting

How California Makes Provision for Public Utilities Told in California Highways

The Maintenance Department of the Division of Highways of the State Department of Public Works of California, has under its supervision all matters relating to permits for work or encroachment on the state highways. Some 4,000 permits were issued during 1926, the cost of special investigation by the district offices and necessary detail being $13,000. The limitations imposed by these permits on overloads and private encroachments insure a protection to the highways and their development which amply justifies the expense involved.

Regulations governing the placement of roadside trees and public utilities are of particular interest, presenting as they do a conflict of the aesthetic and commercial when located within narrow rights of way.

685 Miles of Highways Planted.—Many individuals and organizations have interested themselves in highway beautification, some 685 miles of highways having been planted with roadside trees, the annual cost involved in their care and replacement representing an expenditure of 2 cents of each dollar appropriated for general maintenance work.

The highway right of way is also considered the natural location for utilities as service can be furnished with a minimum of extension lines and the cost of private right of way need not be added to the established rates.

The success of the tree planting movement, however, has placed a burden on the pole line companies, as the earlier plantings have reached sufficient height to interfere with wires and cause "cross-talk" on the telephone and electric disturbances on the power wires. To avoid topping or cutting unsightly notches through the trees, it is necessary either to raise the wires on longer poles or to move the lines. The public utility companies appreciate the value of the trees and generally where trimming has been permitted, the work is satisfactory. However, occasionally through carelessness, an unsightly job is done and the public's immediate protest indicates their active interest in roadside trees.

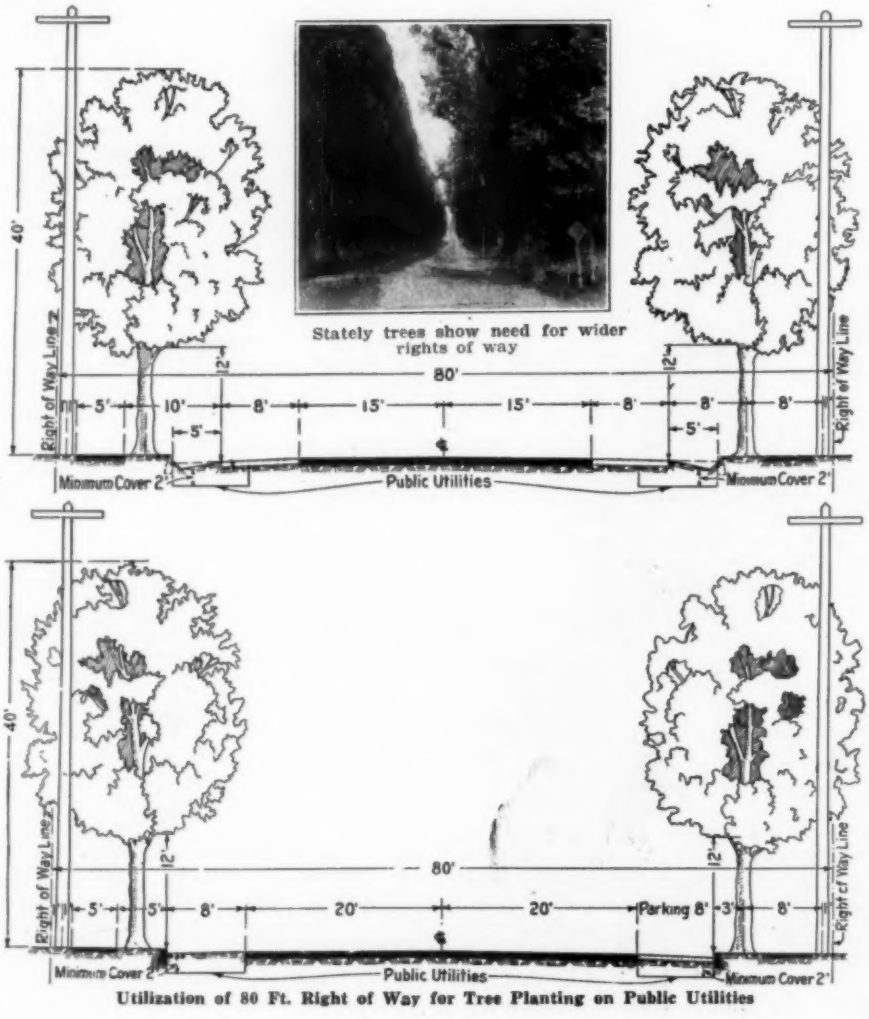
Assignment of Definite Locations.—To minimize this conflict and satisfy both, from an aesthetic and economic view, at the same time provide for the future development of the highways, it was necessary to assign some definite location within the right of way to the trees, poles and service utilities. Placing trees too close to property lines has often resulted in damage to them from the stock within the adjacent fields. Proper cultivation and protection from fire is also hampered by too close proximity to property lines, and the cost of watering increases when trees are located beyond the reach of our one man tree watering units. Placing poles along the tree line means interference with proper tree growth and, due to continuous trimming for wire clearance, handicaps growth and development of the trees.

For these reasons it was decided to place the poles at the right of way line and the trees adjacent to the curb line. The trees at the future curb line will in time present a vista of green banked foliage restful to the eye of the motorist and to a large extent hiding the unsightly poles.

The location and maintenance of pole lines within the highway right of way and their interference with trees was recently the subject of a thorough discussion before the Highway Commission and the Director of the Department of Public Works by a committee representing practically all of the public utility companies of the state. The conclusion reached substantiated the policies of the Maintenance Department.

The drawings shown represent the proposed ultimate sections for 2 and 4 way traffic lanes for 80 ft. width of right of way. In effect, they reserve on an 80 ft. right of way a clear zone of 56 ft. between curbs for road purposes, the remaining space being available for trees, pole lines and sidewalks for pedestrians.

Some Wisconsin Concrete Paving Records.—A new record for concrete road construction in Wisconsin is reported to have been made during the past season by the E. W. Hallett Co., Crosby, Minn. This firm placed 1,666 lin. ft. of 20 ft. concrete in 13 hours and 50 minutes, with a 32-E 9-bag batch concrete mixer and also established a record with 6,602 lin. ft. for the weekly high run. The 1926 record for concrete paving had previously been broken during the season with runs of 1,355 ft. and 1,526 lin. ft. in 14 hours and 17 hours, respectively, by the Kramp Construction Co., Berlin, Wis., and a run of 1,363 lin. ft. in 15 hours by the Schuster Construction Co., Denmark, Wis.



Utilization of 80 Ft. Right of Way for Tree Planting on Public Utilities

Penetration Macadam in Illinois Towns

How Contractor is Paving Small Community Streets at Low Cost With Assurance of Long Service—Men and Equipment Required—Typical Specifications

In Elmhurst, Illinois, the citizens favor asphalt penetration paving for residential streets, and for the past four years the Rockford Road Construction Company has constructed a large percentage of this paving. The company specializes in bituminous construction and surface treatment work, and operates a fleet of ten bituminous distributors over the Northern Illinois territory.

At the time this article was written the contractor was paving DuPage and Berteau Avenues South from Lake Street to North Avenue. The total yardage was approximately 5,500 sq. yd. Only a small job, but it was done late in the Fall and quick work was necessary in order to take full advantage of the few days of good weather remaining. The concrete curb and gutter were constructed first and the grading followed. On account of the small amount of excavation, and the short haul, the grading was done with teams and Freznos hauling direct from the street roadway across the curb and sidewalk into parkways and low vacant lots which property owners desired filled. About ten "three-ups" were used for this work.

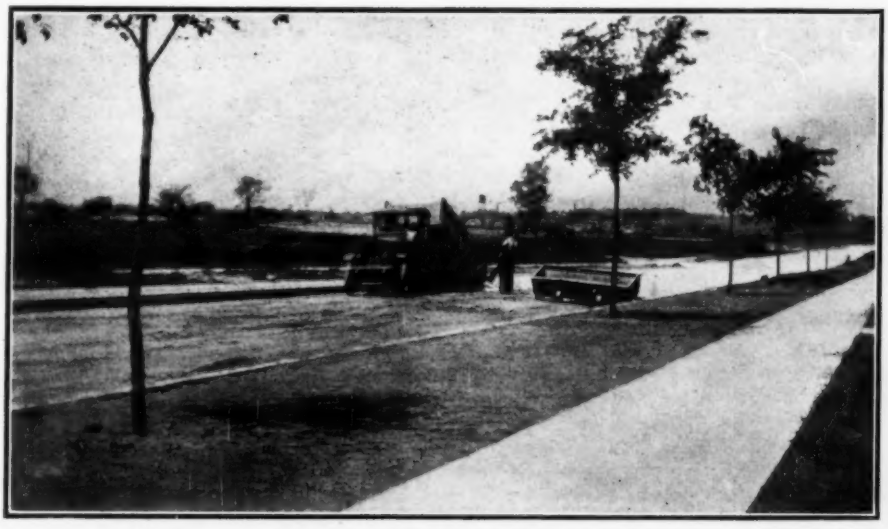


Fig. 1—Dumping Base Course Stone and Spreading by Means of Mechanical Spreader on Back of Truck, Left; and on Right, a Spreader Waiting for the Next Truck

After rough grading, manholes were adjusted and new catchbasins constructed. The fine grading was then handled by four men and rolling of the sub-grade with a ten-ton three-wheel gasoline roller immediately followed.

Base Course.—Crushed limestone for the base course was hauled from the Elmhurst quarry, a distance of about two miles from the job, and spread over the sub-grade by mechanical stone spreaders attached to the back of the trucks. Some 12 trucks were used during this operation. No. 5 stone (3½ to 5 in.) was used on the first course, spread to a depth of 5 inches compacted. Four men worked along with these spreaders straightening up the stone as it was dumped on the sub-grade, and after brief preliminary rolling the trucks began to haul limestone screenings over the base course stone. The screenings were well distributed over the stone, so as to fill all voids, after which the stone was dry rolled and more screenings spread. Following this the water-binding commenced and continued until the base was well screened and waterbound, constituting a solid course of stone and screenings firmly bound together. A period of forty-eight hours was allowed to elapse to permit the bottom base course to dry out before a similar procedure was followed for the second layer of base course.

This was constructed of No. 4 (2½ to 3½ in.) stone which is about one inch smaller in size than the stone used in the construction of the bottom base course. This second course was spread to a compacted depth of 3 inches.

Double Fork for Spreading.—One feature in connection with the spreading of the stone was the type of fork used by the men leveling off the stone. They used a type of fork which was so curved that it was possible to hook two forks together and men work opposite each other pulling back and forth. This method was an improvement over the ordinary one in that each man secured the maximum action from his own rake on the pull stroke, and in addition helped his partner on the back stroke. This made it possible for two men working together to level stone much faster than is ordinarily the case, and better work resulted.

Penetration Surface.—Over these two layers of waterbound base course, having a total depth of 8 inches, a two and one quarter inch asphalt penetration wearing surface was constructed. This consisted of No. 3 stone spread to a loose depth of 2½ to 3 in., rolled once to key it together, over which was applied by motor driven air pressure distributors 1¾ gallons asphalt binder, 95 penetration per square yard. Over this was spread a uniform covering of ¾ in. stone chips, to fill the voids between the No. 3 stone. After rolling the loose chips not held in place were swept off. This operation is important, as the usual mistake is to spread an excess covering of keystone. Over the keystone was applied a seal coat of ½ gal. to the sq. yd., also of 95 penetration binder, this in turn being covered with washed pea gravel and again rolled.

The keystone and gravel were spread by hand by two men shoveling from one-ton Ford dump trucks. The contractor used two trucks side by side, traveling in reverse down the street, each crew covering half the roadway width. Light trucks are used to avoid cutting ruts in the freshly asphalt-bound stone.

Application of bituminous material was made by distributors of a special design built especially for the contractor and incorporating the latest improvements. A sprinkling can with a special spreader spout is used for applying the bituminous material, should the distributor miss a step of stone during this course of its work.

Double Seal Coat.—The final or "double-seal" coat consisted of a cut-back asphalt, applied uniformly one-third gallon to the square yard, and covered with a mixture of clear torpedo sand and pea gravel, followed bvy rolling.

The contractor has made it his policy never to build penetration macadam without applying the double seal coat. The light bituminous material of the double seal coat is used to cut-back the heavier binder on the surface and the fine aggregate of torpedo sand and small gravel fills all surface voids. This gives a tightly sealed smooth surface which is impossible to secure with the single seal coat.

In the application of the "double seal," however, expert knowledge is

Fig. 2—Putting Finishing Touches on Base Course Prior to Rolling

necessary to avoid an excess of bituminous material on the surface, with its attendant evils of soft spots and bleeding in warm weather.

Double Seal Coat.—The final or "double-seal" coat consisted of a cut-back asphalt, applied uniformly ⅓ gal. to the square yard, and covered with a mixture of clean torpedo sand and pea gravel, followed by rolling.

The Contractor has made it his policy never to build penetration macadam without applying the double seal coat. The light bituminous material of the double seal coat is used to cut-back the heavier binder on the surface and the fine aggregate of torpedo sand and small gravel fills all surface voids. This gives a tightly sealed smooth surface which is impossible to secure with the single seal coat.

In the application of the "double seal," however, expert knowledge is necessary to avoid an excess of bituminous material on the surface, with its attendant evils of soft spots and bleeding in warm weather.

Specifications Used.—The Elmhurst work, done under the supervision of the Ed. Hancock Eng. Co., of Chicago, was governed by the following specifications that are used as standard by that engineering firm:

Bituminous Macadam Pavement

Grading.—The roadways of the specified streets including street and alley returns shall be so graded, that after being thoroughly rolled and compacted with a roller of not less than ten tons in weight, the surface of said roadway subgrade shall be ten inches below the surface of the finished pavement, and the parkways graded to the lines as given by the Engineer, which in general shall be a uniform slope from the walk to the curb.

Extra Concrete Over Trenches.—Where an excavation has been made in the subgrade during the past year, the Contractor shall dig out for a width of three feet wider than said excavation, the full length of said excavation in the subgrade, and to a depth of six inches. This digging shall be done after the subgrade is rolled, the bottom of said excavation thoroughly tamped, and then said excavation filled with concrete composed of one part Portland cement, three parts torpedo sand or limestone screenings and six parts broken limestone or gravel, thoroughly mixed and tamped into place. This same extra concrete shall be placed over the trenches made in the subgrade of the roadways for this improvement for any underground work herein without extra cost to the city.

Filling.—Where filling is required in the preparation of the subgrade for new pavement, it shall be made of good firm soil free from loam or vegetable matter or stone in excess of five inches in any dimension, and deposited in layers not more than six inches in thickness and thoroughly wetted and compacted by rolling with a roller of not less than ten tons in weight, and for resurfacing the filling shall be made with broken limestone bonded with limestone screenings and thoroughly wetted and rolled with a ten ton roller.

Disposal of Surplus.—In the grading of the roadways and parkways all surplus earth not needed for the filling of low places and bringing them to grade, shall be disposed of by the Contractor.

If any clean macadam is obtained in said grading, the city shall have the right to state where it shall be placed; but the Contractor shall not be put to any extra expense in said grading so as to keep the macadam separate from the dirt, or to haul it in excess of one-half mile without extra compensation.

Resurfacing.—(Not in this contract) The roadways of the streets, between the gutter flags, shall be scarified and shaped, and have added to the existing foundation, sufficient broken limestone, of a size to pass a ring two (2) inches in diameter and retained on a ring one (1) inch in diameter, together with limestone screenings to fill the voids therein, to bring the surface of the foundation two (2) inches below the surface of the completed pavement, after being thoroughly flooded with water and rolled and compacted with a roller of ten (10) tons weight.

Upon this foundation, as constructed and after it is thoroughly dry, a wearing surface two (2) inches in thickness, after being thoroughly rolled and compacted, shall be laid.

Said wearing surface shall be composed of broken limestone, broken so as to measure not more than two (2) inches nor less than one (1) inch in any dimension. After the spreading of this stone, the roller shall be passed over it to thoroughly key the stones together and bring the surface to the established grade of the street. No water shall be used in this course, and when the stone is thoroughly dry the bituminous binder shall be applied under pressure, by means of a mechanical spreader, or some other method which will insure an even distribution of the bituminous binder and a complete coating of the exposed surface of all stones. One and three-quarters (1¾) gallons of bituminous binder per square yard of pavement shall be

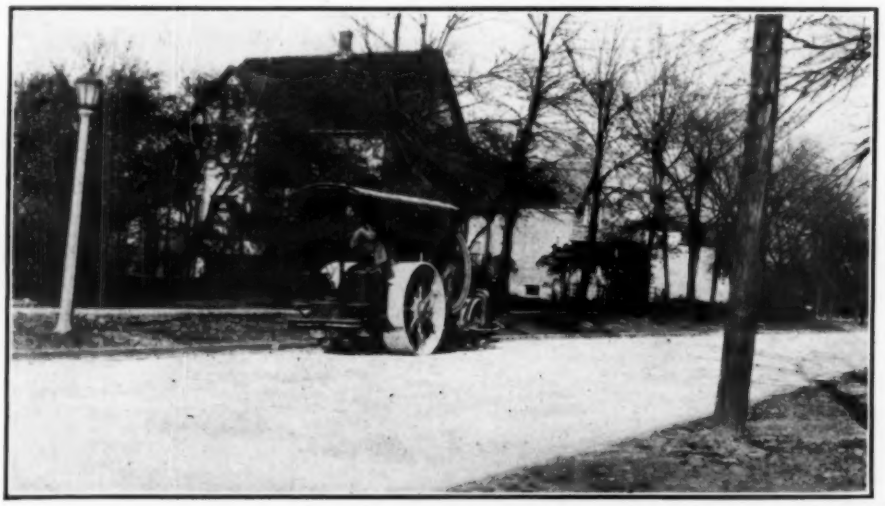


Fig. 3—Rolling the Base Course on Elmhurst Work

spread at this application. The temperature of the binder at the time of the application must be between two hundred fifty (250) and three hundred fifty (350) degrees Fahrenheit.

Immediately after the application of the bituminous binder, limestone chips, dry and free from dust, and all of which shall pass a one-half (½) inch screen, shall be evenly spread over the surface, so as to completely fill all the voids, and the surface rolled with a roller of not less than ten (10) tons weight, until the surface is smooth and true to grade and shows no signs of further compressibility.

Any excess chips shall then be removed from the surface of the roadways, and the second pouring of the bituminous binder applied, which shall be applied in the same manner, at the same temperature as the first pouring of binder, and to the extent of one-half (½) gallon per square yard of pavement.

Immediately upon this application of the bituminous binder, a layer of limestone chips, dry and free from dust, shall be applied to a depth of one-quarter (¼) inch and the pavement thoroughly rerolled with a roller of not less than ten tons weight.

The grade of the center of the completed pavement of the streets shall be two (2) inches above the average elevation of the opposite curbs, and a cross section of the top surface of said finished pavement shall be a true arc of a circle passing through a point one-half (½) inch above the upper and roadway corner of the gutter flag and the grade of the center of said finished pavement.

Pavement.—(New Work). Upon the roadways thus prepared and graded, between said points and between said gutter flags, shall be spread a layer of crushed limestone, broken so as to measure not more than five (5) inches nor less than two (2) inches in any dimension. This layer shall be five (5) inches in thickness, after being thoroughly compacted, and shall be passed over once with the roller to key the stones together, and then covered with sufficient limestone screenings so as to completely fill all interstices, then passed over with the roller, so as to get the screenings to the bottom of the interstices, and then flooded with water and rolled with a roller, weighing not less than ten (10) tons, until thoroughly compacted.

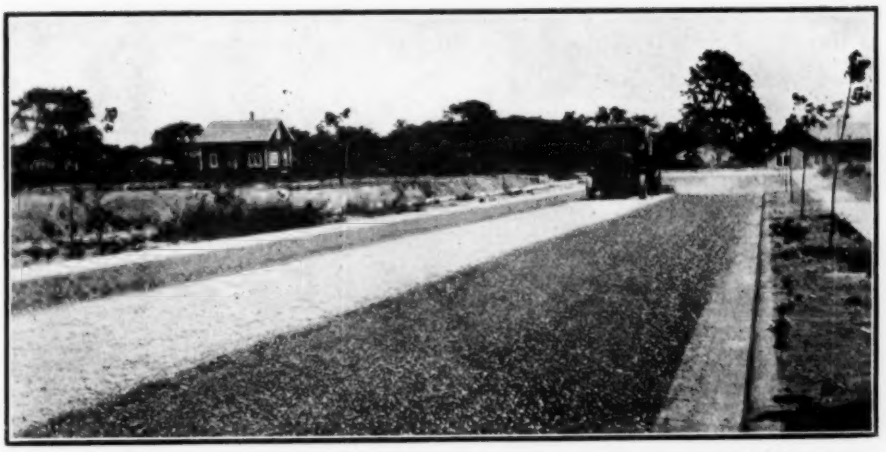


Fig. 5—Distributor Applying 1½ Gal. of Tar Binder per Sq. Yd. Followed Immediately by Covering of ¾ in. Keystone

On this layer, after being compacted, shall be spread a layer of broken limestone, broken so as to measure not more than two (2) inches nor less than one (1) inch in any dimension. This layer shall be of such thickness, after being thoroughly rolled and compacted, so as to be two and one-quarter (2¼) inches below the surface of the finished pavement. After spreading the stone on this layer, the roller shall be passed over it to key the stones together, and then covered with sufficient limestone screenings so as to completely fill all interstices, then passed over once with the roller, so as to get the screenings to the bottom of the interstices, and then flooded with water and rolled with a roller, weighing not less than ten (10) tons, until thoroughly compacted.

Upon this foundation, as constructed of these two layers of stone, and after it is thoroughly dry, a wearing surface of two (2) inches in thickness, after being thoroughly rolled and compacted, shall be laid.

Said wearing surface shall be composed of broken limestone, broken so as to measure not more than two (2) inches nor less than one (1) inch in any dimension. After the spreading of this stone, the roller shall be passed over it to thoroughly key the stones together and bring the surface to the established grade of the street. No water shall be used on this course, and when the stone is thoroughly dry the bituminous binder shall be applied under pressure, by means of a mechanical spreader, or some other method which will insure an even distribution of the bituminous binder and a complete coating of the exposed surface of all stones. One and three-fourths (1¾) gallons of bituminous binder per square yard of pavement shall be spread at this application. The temperature of the binder at the time of application must be between two hundred fifty (250) and three hundred fifty (350) degrees Fahrenheit.

Immediately after the application of the bituminous binder, limestone chips, dry and free from dust, and all of which shall pass a one-half (½) inch screen, shall be evenly spread over the surface, so as to completely fill all the voids, and the surface rolled with a roller, of not less than ten (10) tons weight, until the surface is smooth and true to grade and shows no signs of further compressibility.

Any excess chips or screenings shall be then removed from the surface of the roadways, and the second pouring of the bituminous binder applied, which shall be applied in the same manner, at the same temperature as the first pouring of binder, and to the extent of one-half (½) gallon per square yard of pavement.

Immediately after this application of

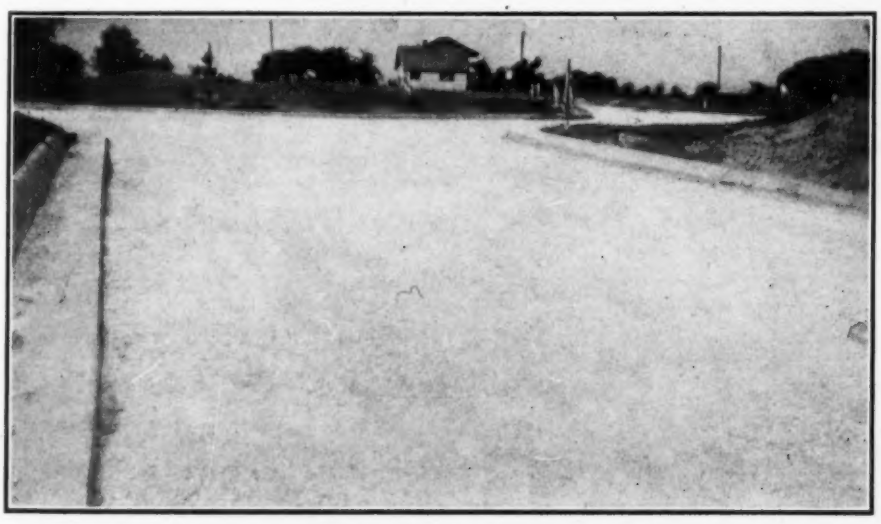


Fig. 4—Waterbound Base Ready for Spreading of Wearing Course Stone

Fig. 6—Applying the First Seal Coat

the bituminous binder, a layer of granite chips or birds-eye gravel, dry and free from dust, shall be applied to a depth of one-quarter (¼) inch, and the pavement thoroughly rerolled with a roller of not less than ten (10) tons in weight.

The grade of the center of the completed pavements of the streets shall be two (2) inches above the average elevation of the opposite curbs, and the grade of the center of the completed pavement of the alley intersections shall be two (2) inches below the top of the curbs. A cross section of the top surface of said finished pavement shall be a true arc of a circle passing through a point one-half (½) inch above the upper and roadway corner of the gutter flags and the grade of the center of said finished pavement.

Bituminous Binder.—The bituminous binder, if a tar binder, shall be free from water and organic materials. It shall have a specific gravity between 1.19 and 1.29 at sixty (60) degrees Fahrenheit, and shall be equal and similar to the product of the Barrett Manufacturing Company known as "Tarvia X." The bituminous binder, if an asphaltic binder, shall comply with the following specifications:

It shall have a specific gravity, at 77 degrees F., of not less than one (1.0).

The bitumen of the asphaltic cement shall be soluble in carbon tetrachloride, to the extent of at least ninety-eight and one-half per cent (98½%).

The fixed carbon of the asphaltic cement shall be not less than fourteen per cent (14%).

The melting or softening point of the asphaltic cement shall be not less than one hundred twenty (120) degrees F., nor more than one hundred thirty-five (135) degrees F.

The asphaltic cement, at 77 degrees F., with one hundred (100) grams for five seconds, shall have a penetration of from ninety (90) to one hundred (100), which shall be varied within these limits to adapt it to the particular asphalt used and to conditions of the street. When fifty (50) grams of the asphaltic cement, of the consistency used in the paving mixture, are heated for five (5) hours at a temperature of three hundred twenty-five (325) degrees F., in a tin box two and three-sixteenths (2 3/16) inches in diameter by one and three eighths (1⅜) inches deep, there shall not be volatilized more than one per cent (1%) of the bitumen, nor shall the penetration, after such heating, be less than one-half (½) the original penetration.

Said asphaltic binder shall be similar and equal to the product of the Texas Company known as "Texaco No. 96."

The bituminous binder shall be applied from motor tank trucks, equipped with pressure spraying apparatus. Said pressure for applying the binder shall be between fifteen and thirty pounds per square inch so as to insure a thorough coating with bituminous binder of all the stone in the wearing surface. No binder shall be applied when the temperature is below 45 degrees F. and the surface of the stone shall be bone dry.

The Contractor shall make a third application of bituminous binder. This application shall be made to the extent of one-third gallon per square yard, thoroughly covered with granite chips or birds-eye gravel, to the extent of .01 cubic yards to one square yard of pavement and rolled with a ten ton roller. Said binder shall not be applied until the Engineer orders it, which will be after the traffic has produced the proper condition in the surface of the pavement and will be from three to six months after opening the pavement to traffic. The fifteen per cent reserve will not be held up however until this application of binder. The surface of the pavement shall be swept clear of all dust, dirt or screenings, and all loose or caked material removed before applying the bituminous binder and the surface shall be bone dry when the binder is applied.

Said bituminous binder shall be a tar or asphalt binder according as to whether tar or asphalt was used in the construction of the pavement and be approved by the Engineer.

Torpedo Sand or Limestone Screenings.—The torpedo sand, crushed granite or birds-eye gravel used in this improvement shall be clean, sharp, graded from fine to coarse, and passing, when dry, a screen having one-quarter (¼) inch diameter holes; shall be preferably of silicious material, clean, coarse, free from dust, soft particles, loam, vegetable or other deleterious matter, and not more than three (3) per cent shall pass a sieve having one hundred (100) meshes per linear inch.

Limestone.—The broken limestone used in this improvement for the pavement, shall be graded in size, retained on a screen having one (1) inch diameter holes, and passing a screen having two (2) inch diameter holes; shall be clean, hard and durable, free from dust, vegetable or other deleteri-

Fig. 7—Spreading Gravel Covering Over First Seal Coat

ous matter, and shall contain no soft, flat or elongated particles.

Resurfacing Work.—Wheaton, Illinois, was then visited. Here the same company had several contracts for resurfacing old macadam streets in the south side of town. Naperville street south from the DuPage County Court House to Roosevelt Road, was one of the streets being scarified, reshaped and rerolled, and resurfaced with tar penetration. Part of it was the regular penetration with heavy tar binder and the remainder modified penetration with medium Tar. The methods used in this construction were interesting.

The old pavements were originally waterbound macadam, surface treated with tar and asphalt. Ditches for construction of underground improvements, service cuts, holes and depressions in the pavement made necessary a complete resurfacing and because of the successful results obtained in similar work in other cities by this contractor, the City of Wheaton awarded them contract for resurfacing with tar penetration.

Scarifying.—For scarifying the old pavement the Contractor used a 12-ton Austin gas roller equipped with pneumatic 7-tooth scarifier. On account of the very solid surface of the pavement, it was necessary to start the scarifying with two scarifier teeth only, using more teeth as the surface became broken up. The pavement was scarified to a depth of 3 to 4 inches and then the loose stone was shaped to proper grade and crown with a blade grader. The surface was then rolled to ascertain where new stone would be necessary in order to secure a uniform texture in the surface, and also to fill in the low spots which developed during the rolling. For this medium macadam stone was used.

The surface was then given a prime coat of light tar which serves the purpose of penetrating into the road for a depth of ½ inch to 1 inch, as well as leaving enough tar on the surface for the subsequent layers of stone chips to adhere to. Following the prime coat of tar the roadway was lightly covered with ½ inch stone chips, and one day was allowed to elapse in order to permit the tar to dry out and set up. A second application of light tar was then made, and this also was covered with stone chips ¼ inch in size.

Fig. 9—Scarifying and Rolling Old Macadam in Wheaton. Teeth Behind Roller Give Combined Ripping and Rolling Action That Soon Breaks Up the Surface into Clean Stone

The surface was then given a thorough rolling and closely inspected to see that it had a uniform covering of stone chips and that all places in the road contained the same mixture of tar and stone. The final seal coat was then applied, consisting of a slightly heavier tar, and this application was covered with a mixture of washed pea gravel and clean torpedo sand, after which the roadway was given a final rolling.

This contracting firm has also performed similar work on Willow Avenue from Naperville Street West to Hale Street. This also was an old waterbound macadam road that had been cut up considerably for water and gas connections. The portion in front of the DuPage County Court House was widened from 30 to 36 feet and new curb and gutter constructed on both sides. In the remaining portions of the street wherever the curb and gutter were broken or cracked, they were taken out and replaced with new curbing. The sidewalks were also checked over at the same time, and wherever the old sidewalk had settled down or cracked, it was taken out and new sidewalk constructed at the proper grade.

Difficult Intersection.—In the course of the work on both Willow Avenue and Naperville Street, the Contractor had to be very careful with grades at the street intersections. A good many of the side streets were of concrete, somewhat flat and with hardly any crown, whereas both Willow and Naperville were old macadam streets with a high crown. This made it difficult to build the intersections low enough so that traffic North and South, and East and West could ride over the intersections without feeling any irregularities in the surface. At the intersection of Roosevelt Road and Naperville Street, an old monument had to be taken out in order to permit the widening of the intersection and building the approach to Naperville Street with a wider radius.

Starting at Roosevelt Road, the property on the East side of Naperville Street for about 400 feet North of Roosevelt Road is approximately 5 feet higher than the property on the West side. The property holders had been complaining to the City that with the pavement four or five feet lower than their property grade, it was impossible for them to construct driveways connecting their grades to the street without having a steep incline. To correct this condition, the City decided to raise the level of the pavement along the West curb 12 to 15 inches, and this was accomplished by constructing the new curb and gutter directly on top of the old curb and gutter, and constructing the new penetration macadam pavement on top of the old street at the

Fig. 8—Tar Penetration Pavement Six Months After Completion

West curb. The waterbound macadam then was spread over the old pavement to a depth varying from 3 to 12 inches, and at the East end of the street the old pavement was scarified so that the waterbound base could be tapered down to a depth of about 2 inches. After shaping and rolling this waterbound base to the proper grade and crown, a 2½ inch tar penetration top was then constructed over the entire width of the street.

The Wheaton work was done under the direction of George W. Stickney, City Engineer.

River Forest Work.—The writer learned that in two other cities nearby the same contractor has recently completed two similar projects. In the Village of River Forest, they scarified and resurfaced with a 2½ inch top the old waterbound macadam pavement on Iowa Street from Harlem Avenue

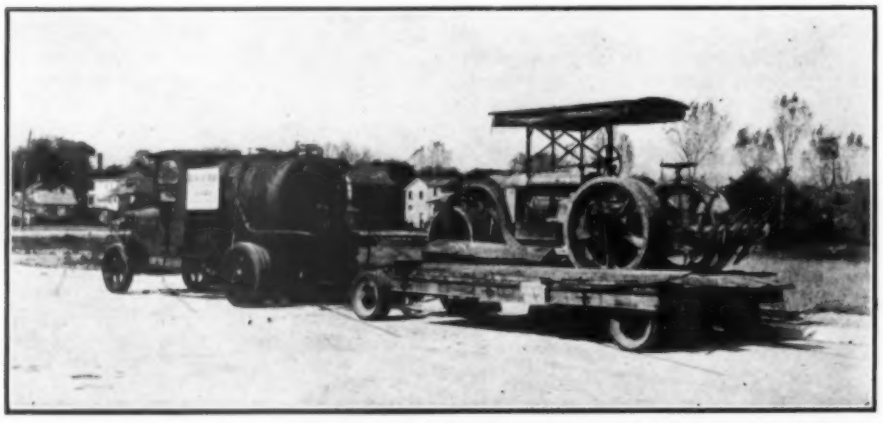


Fig. 10—A Distributor Towing Small Roller with Scarifier, on Trailer, to New Job. A Large Roller Is Moved Under Its Own Power

West to Lathrop Avenue including all the street intersections. The street had had about four months of traffic when the writer saw it at the time this article was written, and it had ironed out to a smooth texture resembling asphaltic concrete in appearance. In the City of Lake Forest the Rockford Road Construction Company, during July and August, widened and resurfaced Deerpath Avenue from Green Bay Road East to Bank Lane. On Deerpath Avenue the old pavement was waterbound macadam surface treated with tar or asphalt, about 24 feet wide. This street was widened to 44 feet at Bank Lane, narrowing gradually to a width of 30 feet at Green Bay Road. New curb and gutter, new sidewalks, new catchbasin inlets with new underground drainage were included in this improvement, and this street also had ironed out to a very smooth finish.

The company is now said to be experimenting with a new type of surface for their bituminous penetration construction, and they expect that with this new type of surfacing they will obtain a surface just as waterproof, smooth and durable as any other type of pavement, be it asphaltic concrete, sheet asphalt, or any similar type of blacktop pavement.

Salvaging Old Pavements.—Aside from their activity in the construction of new bituminous penetration pavements, this contractor is constantly salvaging old pavements. They have various methods which they recommend for salvaging old pavements, varying from a light surface treatment to a complete resurfacing with 3 inch bituminous wearing surface, using the old pavement as a base.

So successful were their early activities in this territory, the company originated the policy of guaranteeing their work for periods varying from one to five years, backing up their guarantee with a maintenance bond issued by one of the largest surety companies. Whether a job is guaranteed for two years or five years depends on the character of the paving work, conditions of road bed, drainage, etc. Four of the company officials are actively engaged in promotion sales and construction work, each man covering a certain territory in the district of Northern Illinois between the east and west boundaries of the state. They have also been active in Wisconsin.

In order to provide work for their organization 12 months of the year, this company is one of the few road contractors with a winter business. The company owns and operates the North Shore Petroleum Co. a subsidiary organized to sell and deliver fuel oil to homes, hotels or apartments and factories. A fleet of 5-ton GMC trucks is used for fuel oil delivery, the distributor tanks being removed and the regulation type of gasoline and oil tank mounted in its place.

Plant and garage are located at 5929-41 Rogers Avenue, on the extreme northwest side of Chicago, where the company also maintains its general office for both the paving and fuel oil divisions.

Study of the Factors Governing the Strength of Concrete

From November Technical News Bulletin of U. S. Bureau of Standards.

The bureau has completed a study of the variables entering into the fabrication of concrete, in which 3,000 cylinders were prepared and tested. Some tentative conclusions from these tests have already been reported in the November, 1926, Technical News Bulletin under the title "Water-cement ratio in concrete."

The variables studied are as follows:

1. Quality of cement. Four brands of Portland cement with different characteristics were used.

2. Gradation of the coarse aggregate. Eighteen gradings were studied.

3. Ratio of fine to coarse aggregate, four ratios being used.

4. Types of aggregates: Gravel, slag, and crushed limestone.

5. Age. The specimens were tested at six ages, namely, 1, 3, 7 and 28 days, and 3 and 12 months.

6. Proportions of mix. 1:1½:3, 1:2:4, 1:3:6 mixes were used in most part.

The specimens were removed from the molds at 24 hours and then placed in damp storage until test. All concrete was made of such consistency as to develop a flow of 95 as measured by the flow table, using 15 ⅛-in. drops The following conclusions may be drawn from the results of the tests:

1. At the ages of 1, 3, 7 and 28 days the variations in quality of the cement produced marked differences in the strengths of the 1:2:4 concrete. At the 3-month age, however, the difference in strengths was 9 per cent in term of the strength of the lowest one, and there was about 6 per cent at the age of 1 year.

2. The ratio of the strength of the concrete made from the four cements at 28 days varied from 1.96 to 2.76 of the strength at 7 days, under the conditions affecting this series of tests.

3. The proper ratio of fine to coarse aggregate for maximum strength depended on the type of the aggregate and its grading.

4. In most cases, when the coarse aggregate was deficient in one or two of the smaller sizes, that is, those varying between No. 4 to ⅜ in. and ⅜ to ¾ in., a markedly better workability, together with very little change in strength, was obtained when using a mix in which the fine aggregate was 50 per cent of the total aggregate than when the fine aggregate was less than 33⅓ per cent of the total aggregate.

One Course Concrete Curb Construction

How Modern Methods Produced Remarkable Results at Detroit Told in Concrete Highways

One of the most interesting developments following the widespread adoption of one-course concrete curb and combined curb and gutter has been the remarkable records established for amounts of curbing built in one working day. Many excellent plans have been perfected with the result that time and labor costs have been reduced and wasteful practices have been abandoned in favor of modern methods which place curb work on a plane with advanced street paving construction.

A View of the Concrete Crew. The Placing and Finishing Operations Are Kept Close Behind the Mixer

One of the first contractors to organize one-course concrete curb construction in such a manner as to eliminate heavy wheelbarrow labor and to increase the amount of curbing built in one day by one crew with one mixing machine was the Mark R. Hanna Co., R. W. Burks, superintendent in charge of construction, of Detroit, Mich. That the method developed is also applicable to combined curb and gutter work is evidenced by the fact that the R. D. Baker Co., using methods very similar, built as much as 2,800 lineal ft. of combined curb and gutter in a nearby city in one working day this season.

Some Production Records.—In 1924 the Hanna Co. used the ordinary 1-bag mixer, with wheelbarrows to charge the skip and to transport the concrete from the mixer to the forms. The average daily production was about 500 lin. ft. This average was raised to about 700 ft. per day in 1925, with 1,200 lin. ft. as a maximum day's run. A typical crew consisted of from 26 to 28 men. In 1926 they experimented with and perfected the organization and method which has enabled one crew of 37 men to place over 201,000 ft. of straight one-course curb from the beginning of the construction season in 1927 to Sept. 1, with a probable total of 275,000 lin. ft. for the season.

The average run is 2,500 lin. ft. per 10-hour day. The maximum day's run this year is 4,063 lin. ft.

How the Work Is Handled.—The following methods were used in order to obtain the above production. A full caterpillar tread 21-E paving mixer was used. An old type paving mixer spout, with a gate near the end was used for delivery of the mixed concrete into the forms. One man holds a wooden splash board in front of the spout in such a way as to direct the concrete into the forms and prevent loss or misplacement.

All curb is placed after the rough grade is completed and prior to fine grading. The mixer is run along the grade about 4 ft. from the curb, the spout swinging out over the curb. Aggregates are mechanically loaded from nearby stock piles into two trucks which haul direct to the mixer and dump into the skip in the usual manner. The mixer operator empties the drum into the spout in small quantities. The man tending the spout operates the small shut-off gate in the spout, and with the splash board operator controls the delivery of concrete into the forms. Two men spade the concrete in the forms, then two float men, one bull nose man, two finishers and one brush man follow in succession. The finished curb is 20 in. deep, 6 in. wide and divided by templates into uniform blocks 6 ft. long. Particular care is taken to see that after the steel separating templates are removed, a clear opening is maintained between the upper 7 in. of the units. A ⅜ in. expansion joint is placed every 24 ft. A bull nose of 1 and 1¼ in. radius is troweled on the top edge facing the street. A one minute mix is specified and maintained. A 1:2:3 mix with 1-in. maximum size aggregate is used. This makes an excellent curb with practically no spalling.

The Man Closest to Mixer Handles Spout Gate, the Next Forward Roughly Spreads and Spades Concrete in Forms, the Third Gives Curb Top a Finished Floating and the Last Man Completes Finishing and Rounds Top, Inside Edge

Another advantageous feature of this type of curb is that should the street require widening the section can easily be moved back and reset, practically without loss. In 1923 the

Geo. R. Cooke Co. paved Dexter Boulevard, Detroit. Due to the subsequent rapid growth in population in this section of the city it became necessary to widen the street in 1926. When the widening was done, the old concrete curb was moved back to the new curb line without the loss of a single unit.

Curb work in Detroit is done under the supervision of the Department of Public Works, John W. Reid, Commissioner, P. A. Fellows, City Engineer.

Sand-Shoeing Motor Traffic

How Chicken Wire Solved Problem of Road Maintenance over Soft Ground

By H. A. FINCH
Major, U. S. Army, Fort Humphreys, Va.

When the Pershing Expedition crossed the border at Columbus, New Mexico, in March, 1916, to chase the bandit Villa, the troops found a dirt road running south to Colonia Dublan, Parral and other Mexican towns on the Villa line of retreat.

This road had been packed and worn smooth and hard by generations of light Mexican wagons. Even the 'dobe stretches were hard and apparently ready to stand up under the punishment inflicted by army truck trains.

Within two weeks the road began to go to pieces, beginning of course with the stretches of sand and 'dobe. Within two months the situation had become serious. On the 75-mile section from Columbus to Colonia Dublan fully 40 miles had disintegrated so badly that the truck trains on which the fate of the expedition at that time depended could not be kept on schedule and could be kept in service only with the greatest difficulty.

On the 'dobe stretches pot holes developed ranging up to 12 and 15 in. in depth. These were concealed by the fine, impalpable dust which filled them. Down would go one or both of the front wheels; up would fly the powdered 'dobe in swirls that made breathing a job and that got in behind even fur-rimmed goggles. Pot hole succeeded pot hole; the long lines of trucks, one by one, blundered into them and laboriously climbed out in low gear, while over all hung a thick pall of dust that turned trucks, cargoes and passengers as gray as Norwegian rats.

On the sand stretches the situation was hardly better. Trucks could get through in second gear provided the trucks ahead kept moving and provided the foot-deep ruts were not filled by the road workers or by trucks that did not track. The worst feature on these stretches was the tendency of the trucks to create humps and hollows in the ruts. A rock or an extra hard bit of sand material would start the business. The wheel would be thrust upward by the obstruction; this brought about a down thrust on the opposite wheel which tended to form a hollow. As wheel No. 1 dropped off the obstruction the down thrust was shifted to that side and a hollow started to match a hump on the other side. Every pair of wheels of innumerable trucks repeated the process and aggravated the condition until there would be a full mile of sand waves to rack the motor vehicles and to distress the desert voyager. The effect on the passengers was even more potent than riding a bucking boat in a cross swell; more than one hard-boiled soldier learned that one does not have to go to sea in order to be "seasick." The chauffeurs had a hard time of it; many did not stand the gaff and most of those who did had to be treated for kidney trouble at one time or another during their service with the expedition.

The army engineers with the expedition have never told the full story of their trials and sufferings. All sorts of schemes were discussed; all sorts of arguments raged. The sand waves could be leveled off but they reappeared in a day or two as soon as the ruts were formed again. On the 'dobe stretches a little relief could be secured at times by detouring over the plains —the Mexican plains dotted with prairie dog hills and covered with sage brush. This relief was totally inadequate.

For a time hopes were had that the approaching rainy season would provide the water to act as a binder for the 'dobe while the sun baked it hard —just as today in the Imperial Irrigation District south of the Salton Sea the custom is to irrigate half of the high-crowned 'dobe roads while the freshly baked other side is in service.

The plan was fine and the hopes were high—but the rains never came, and all the work of laboriously crowning miles of road was lost.

To shorten a long story, no satisfactory solution of the problem was devised during the 11 months the Americans were in Mexico. Of course had it been known in advance that the expedition was to stay in Mexico for that length of time it would have been advisable perhaps to resort to light railways, but the uncertainty of the army's tenure combined with a dearth of equipment ruled this expedient out. Plank roads and concrete pavements were even more out of the question due to the nature of the job in hand and the large amount of material required for this sort of construction.

The only expedient that gave any satisfactory relief was the plan, suggested early and finally adopted, of scraping a roadway out of the ground instead of mounding it on the ground level or about it.

On some stretches it was practicable, after much brushing, to have the heavy-duty road graders scrape off the heavy loose material on top and uncover harder material below. This operation had to be repeated periodically and at best it provided a road surface of hard patches alternating with soft spots—and the hard material soon disintegrated.

Fortunately for the American forces, the Carranzistas wanted Villa caught. They therefore authorized the use of the railroad from El Paso to Chihuahua. But for this it is certain that either the railroad would have been taken over by the Americans forcibly or the troops would have been withdrawn earlier. The expedition could not live on supplies brought in by trucks.

As stated, the army engineers, in spite of prayers and perspiration, found no satisfactory solution of their road maintenance problem. But had they only known it, the solution was fairly simple. Chicken wire would have done the business. This was proven in wholesale and conclusive fashion by Allenby's engineers when the problem confronted them of maintaining roads for the British forces in their drive across 240 miles of semi-desert country between Suez and Jerusalem.

Chicken wire had been largely used on the Allied front in France for revetting trench side walls, and the British supply department had sent quantities of it to Suez on the assumption that it would be used there. However trenches were not resorted to on the Palestine front and the chicken wire, thousands of rolls of it, stayed in storage until some unidentified British engineer conceived the idea of utilizing it for "sand-shoeing" a truck highway across the miles of sandy stretches.

Few details of this successful large-scale experiment have been published in this country, so far as known, but it appears that the wire was of the ordinary 1½-in. mesh and that three strips were used superimposed for each wheel track. The 3-ply "sand-shoe" was pegged down by long wire staples. Some sand sifted upward through the meshes, of course, but in the 3-ply arrangement this was just enough to protect the wire strands from undue wear and not enough to make heavy going for the trucks.

Whether or not the engineer would have hit on the solution of his problem if the chicken wire had not been under his eye is not the question. The outstanding fact is that this expedient simplified a most difficult problem. It is doubtful if any other one thing contributed so much toward the success of Allenby's campaign in Palestine.

Wisconsin County to Vote on $2,553,000 Bond Issue.—Sheboygan County, Wisconsin will vote April 3 on an $2,553,000 bond issue for road improvements.

State Highway Construction in 1927 and 1928

Reports from State Officials Showing Mileage and Expenditures Last Year and Proposed Mileage and Funds Available for This Year

New England States

Maine

During 1927 62 miles of state highways were complete. This included 15 miles of reinforced concrete pavement, 7 miles of bituminous macadam and 40 miles of gravel road. Some details of the 1927 work are given in the accompanying tabulation:

Maine State Highway Completed in 1927

Type	Miles	Average width surfaced ft.	Thickness in.	Approx. Aver. cost per mile
Reinforced Concrete	7.17	27	7-9	$71,300
Reinforced Concrete	3.89	20	7-9	52,800
Reinforced Concrete	3.98	18	7-9	46,900
Bituminous Macadam*	7	20	....	32,600
Gravel**	40	18	....	19,400

*2½ in. surface; 10 in. to 12 in. base.
**4 in. to 6 in. surface; 8 in. to 10 in. base.

The incompleted state highway work carried over to 1928 included 5 miles of bituminous macadam involving probable expenditures of $160,000, and 15 miles of gravel road involving an expenditure of $240,000.

The program for 1928 calls for the following new state highway work:

Type	Miles	Probable Expenditure
Reinforced concrete	10	$700,000
Bituminous macadam	20	600,000
Gravel	25	475,000

The contract unit prices on 1927 work were as follows:

Description	Unit	Average
Clearing and grubbing	acres	$225.00
Earth excavation	cu. yd.	1.126
Rock excavation	cu. yd.	3.80
Trees removed	each	13.80
Excavation for structures	cu. yd.	1.55
Stone fill	cu. yd.	2.375
Common borrow	cu. yd.	1.1055
Gravel borrow	cu. yd.	1.55
Gravel sub-base	cu. yd.	2.156
Gravel base course	cu. yd.	1.8653
Stone base course	cu. yd.	2.8222
Crushed stone base course	cu. yd.	4.375
Gravel surface course	cu. yd.	1.959
Bit. Mac. surface course	cu. yd.	5.125
*Bit. material applied, delivered in barrels	gal.	0.055
Cement concrete pavement	cu. yd.	12.25
Bar reinforcement for pavement	lb.	0.0433
Class "A" concrete	cu. yd.	26.333
Class "B" concrete	cu. yd.	23.333
Reinforcement for concrete	lb.	0.0782
Cement rubble masonry	cu. yd.	10.00
**Laying 12 in. C.M.P. culverts	lin. ft.	0.7636
**Laying 15 in. C.M.P. culverts	lin. ft.	0.7611
**Laying 18 in. C.M.P. culverts	lin. ft.	0.905
**Laying 21 in. C.M.P. culverts	lin. ft.	0.65
**Laying 24 in. C.M.P. culverts	lin. ft.	0.9916
**Laying 30 in. C.M.P. culverts	lin. ft.	1.00
**Laying 36 in. C.M.P. culverts	lin. ft.	1.70
**Laying 15 in. C.I.P. culverts	lin. ft.	0.9375
**Laying 18 in. C.I.P. culverts	lin. ft.	0.95
**Laying 24 in. C.I.P. culverts	lin. ft.	1.20
**Laying 30 in. C.I.P. culverts	lin. ft.	2.25
**Laying 36 in. C.I.P. culverts	lin. ft.	2.00
Drop inlets	each	65.00
Catch basins	each	100.00
Plain riprap	cu. yd.	2.50
Tile underdrain	lin. ft.	1.50
Cobble stone gutter	sq. yd.	1.50
Wire cable guard rail	lin. ft.	0.825

*Material furnished by state. Price bid is for delivery from railroad station, heating and applying.
**Culvert pipe furnished by state. Price bid is for delivery from railroad station to job and installation.

Paul D. Sargent, Augusta, Me., is chief engineer state highway commission.

New Hampshire

The state highway work completed in New Hampshire in 1927 included 15 miles of 18 ft. wide, 6 in. thick reinforced concrete pavement and a like amount of 18 ft. wide, 6 in. thick bituminous macadam. In addition 17.5 miles surface treated gravel road and 75 miles of 21 ft. wide state aid gravel roads were completed.

The construction program for 1928 includes the following:

	Miles
Concrete	12
Bituminous macadam	15
Gravel surface treated	20
State aid gravel	75

The following tables show the sources of revenue and the expenditure for 1927 and the probable revenue and expenditures for 1928.

Revenue 1927

State Highway Dept.—	
Gas tax	$1,300,000
Automobile fees	1,800,000
Federal aid	365,000
County, city or town	1,510,000
Appropriated by municipalities outside of state work	3,000,000
Total	$7,975,000

Expenditures

State Highway Dept.—	
State funds	$3,100,000
Town and city funds	1,510,000
Federal aid	365,000
	$4,975,000
Municipalities	3,000,000
Total	$7,975,000

New Hampshire Revenue and Expenditure, 1928

Gas tax at 4 ct.	$1,800,000
Automobile fees	2,000,000
Direct appropriations	none
Federal aid	365,000
City and town appropriation	1,500,000
Bonds, flood emergency	3,000,000
Other sources	none
Total	$8,665,000
Construction	$1,725,000
Reconstruction	1,000,000
State aid	590,000
Maintenance	2,000,000
Office administration	50,000
M. V. Dept. administration	125,000
Bridges	100,000
Special resolutions	none
Snow removal	75,000
Bonds, flood emergency	3,000,000
Total	$8,665,000

The floods of last November caused an estimated damage of $2,500,000 to roads and bridge. To repair these damages the state legislature authorized a bond issue of $3,000,000.

Frederic E. Everett, Concord, N. H., is state highway commissioner.

Rhode Island

The state highway work completed in 1927 in Rhode Island included 15.9 miles of reinforced concrete pavement, 20.66 miles of bituminous macadam, 2.1 miles of sheet asphalt and 2 miles of macadam. Details of this work are given in the table.

Rhode Island State Highway Completed in 1927

Type	Miles	Averaged Width Surfaced Ft.	Thickness In.	Average Cost Per Mile
Reinforced Concrete	15.90	20	8	$53,600
Bituminous Macadam	20.66	20	8	$3,700
Sheet Asphalt	2.10	30	3" Sheet on 6" Con. Base	47,000
Macadam	2.00	18	8	22,700

The uncompleted work carried over to 1928 included 11 miles of bituminous macadam involving a probable expenditure of $550,000.

The new state highway work proposed for 1928 is as follows:

Type	Miles	Probable Expenditure
Bituminous Macadam	20.8	$800,000
Reinf. Cement Concrete	7.6	350,000
Street Asphalt on Conc. Base	3.0	200,000

George H. Henderson, Providence, R. I., is chief engineer, State Board of Public Roads.

Vermont

The state highway work completed in Vermont in 1927 included 28.5 miles of reinforced concrete road, 15.1 miles of bituminous macadam and 4 miles of gravel road. The incompleted work carried over 1928 included 4.3 miles of reinforced concrete road and 2.2 miles of gravel road.

It is not possible at this time to give an estimate of the new highway work proposed for 1928. The roads and bridges in Vermont suffered severe damage during the floods of last November. The state legislature has voted an $8,000,000 bond issue for repairing flood damages. The greater part of the money will be expended on highways and bridges.

Hubert E. Sargent, Montpelier, Vt., is Chief Engineer, State Highway Board.

Massachusetts

A total of 260 miles of state highway were completed in 1927, this including 30 miles new state highway, 110 miles old state highway reconstructed and 120 miles town roads constructed under co-operative plan. The total expenditures in 1927 were $10,500,000. It is probable that a like

amount will be spent in 1928. A. W. Dean, Boston, Mass., is Chief Engineer State Highways.

Middle Atlantic States

New York

During 1927, 645 miles of state highway were completed and 674 miles were placed under contract. The cost of awarded contracts for the year plus general maintenance was $48,000,000. It is expected to place under contract in 1928 about 690 miles of state highway at a total cost of about $50,000,000. A. W. Brandt, Albany, N. Y., is State Highway Commissioner.

New Jersey

During 1927 a total of 150 miles of state highway was completed at a total cost of $6,577,000. The plans for 1928 are practically the same as were those for 1927.

W. G. Sloan, Trenton, N. J., is State Highway Engineer.

Pennsylvania

During 1927 there were built by contract, let by the State Highway Department of Pennsylvania, 540 miles of pavement and 45 miles of grading and drainage only. This contract work included not only projects on the state highway system, but also state-aid roads and some township highways. In addition to this contract work the department built, with its own forces, approximately 250 miles of pavement on the state highway system. This work by department forces included approximately 80 miles of surfacing with flexible type pavement and approximately 140 miles of resurfacing with flexible type pavement. The miles of pavement completed by contract included approximately 500 miles of reinforced concrete pavement and approximately 40 miles of flexible type construction. The flexible type construction included principally bituminous surface treated macadam and bituminous penetration macadam.

Uncompleted work carried over into 1928 will amount to roughly 300 miles of reinforced concrete pavement construction.

It is expected that 500 additional miles will be placed under contract by the department in 1928. The major portion of this additional work will probably be reinforced concrete construction.

The accompanying tabulation shows the average unit prices recommended for award from Jan. 1 to Nov. 1, 1927:

Average Unit Prices of Work Recommended for Award by Pennsylvania Department of Highways, from Jan. 1, to Nov. 1, 1927
Reinforced Concrete Surface Roads

TYPE PAVEMENT ONLY

Type	Width Ft.	Sq. Yd.	Unit Prices Per Sq. Yd.	Per Cu. Yd.
7-5½-7	16	89,034	$2.71	$16.88
7½-5½-7½	16	100,703	2.63	15.32
7½-6-7½	16	384,481	2.81	16.08
7½-5½-7½	18			
7½-6-7½	18	87,188	2.65	15.19
8-6-8	16	441,768	2.88	15.53
8-6-8	18	403,328	2.70	14.57
8½-6-8½	18			
8½-6½-8½	18	27,108	3.10	15.57
9-7-9	18	1,164,322	3.01	14.11
9-7-9	20	143,633	2.98	13 98
10-7-10	20	35,656	3.17	14.27
10-8-10	20	14,133	3.60	14.96
6-in. Uniform	Variable			
6½-in. Uniform	"	49,489	2.82	15.63
7-in. Uniform	"	174,946	2.87	14.78
7½-5½-7½	"			
8-6-8	"	24,289	2.94	.....
9-7-9	"	48,338	2.87	.....

Additional Types of Surfaced Roads, All Surface Items

		Sq. Yd.	Per Sq. Yd.
7½-6-7½ B. S. T. M.	16	60,995	$1.44
Bit. Sur. Cr. Sp. "A"	Var.	19,304	1.60
Bit. Sur. Cr. Sp. "E"	"	3,946	1.68
3-in. Vit. Brick	"	37,207	2.32
8-6-8 B. S. T. M.	16	30,757	1.85
3-in. Pene. Reconst. Base Course	16	30,462	1.10

Samuel Eckels, Harrisburg, Pa., is Chief Engineer, Pennsylvania State Highway Department.

East North Central States

Ohio

The total contract price of state highway contracts under construction from Jan. 1 to Oct. 20, 1927, amounted to $23,228,781 and covered 1,275 miles of road and 105 bridge contracts. The contract price of the work completed between Jan. 1 and Oct. 20 amounted to $8,768,970 and covered 593 miles of highway and 50 bridge contracts. On Oct. 20 682 miles of highway work were under construction and 55 bridge contracts, the total contract price being $14,459,810. Practically all of this work was carried over to the 1928 season. The department also constructed 600 miles of traffic bound macadam at an average cost of $3,000 per mile. The accompanying tabulation summarizes the work in 1927.

The program of the State Highway Department of Ohio for 1928 has not been decided definitly. The work, however, will be as extensive as in the 1927 season. The state embarks upon a new system of financing road improvements. Heretofore the system has been cooperative between county and state. No counties having less than three hundred million dollar tax duplicates are permitted to cooperate with state. The law which became effective January, 1928, will allow but 8 counties of 88 to cooperate with the state toward road improvements. Balance of counties will have state road construction independent of county financial aid. State pays all of the cost of these contracts and builds the most important roads first. There will be more grade crossing eliminations in 1928.

Summary of State Highway Works in Ohio

State Highway Contracts Under Construction Jan. 1, to Oct. 20, 1927:

Type	Miles	Contract Price
Concrete	316.779	$ 6,138,282
Surface Treating	247.568	192,523
Traffic Bound Macadam	175.850	352,203
Bituminous Macadam	157.387	4,015,683
Water Bound Macadam	102.527	2,115,994
Brick	82.612	3,921,961
Kentucky Rock Asphalt	23.122	539,954
Sheet Asphalt	4.613	220,584
Warrenite Bitulithic (Hot Mix)	2.520	148,532
Misc. (Guard Rail, Reconstruction widening, etc.)	34.236	684,146
Grading and Drainage Structures	128.020	1,914,282
Bridges (105 Contracts)		2,984,630
Total	1275.234	$23,228,781

Completed Between Jan. 1, to Oct. 20, 1927.

Type	Miles	Contract Price
Concrete	147.932	$ 2,717,921
Surface Treating	117.220	83,546
Traffic Bound Macadam	117.900	231,868
Bituminous Macadam	70.059	1,750,359
Water Bound Macadam	61.138	1,315,997
Brick	19.233	794,663
Kentucky Rock Asphalt	5.909	133,330
Sheet Asphalt	.218	25,660
Warrenite Bitulithic	2.520	148,532
	7.291	104,107
Grading and Drainage Structures	43.748	489,767
Bridges (50 Contracts)		973,216
Total	593.168	$ 8,768,970

Under Construction Oct. 20, 1927.

Type	Miles	Contract Price
Concrete	168.847	$ 3,420,360
Surface Treating	130.348	108,976
Traffic Bound Macadam	57.950	120,335
Bituminous Macadam	87.328	2,265,324
Water Bound Macadam	41.389	799,997
Brick	63.379	3,127,298
Kentucky Rock Asphalt	17.213	406,623
Sheet Asphalt	4.395	194,924
Warrenite Bitulithic		
	26.945	580,039
Grading and Drainage Structures	84.272	1,424,514
Bridges (55 Contracts)		2,011,414
Total	682.066	$14,459,810

Harry J. Kirk, Columbus, O., is State Highway Engineer.

Indiana

A total of 587 miles of state highway roads was completed in Indiana in 1927. This work included 266 miles of concrete, 72 miles of bituminous macadam, 75 miles of macadam and 55 miles of gravel roads. The accompanying tabulation gives some details of the 1927 work.

Indiana State Highway Work Completed in 1927

Type	Miles	Average Width Surfaced, Ft.	Thickness, In.	Average Cost Per Mile
Plain Concrete	266	18	9-7-9	$27,000
Bituminous Macadam	72	18	7-9	18,000
Re-surfacing Bituminous Concrete	0.56	18	.....	14,000
Macadam	75	.....	.....	7,000
Gravel	55	.....	.....	5,000
Bituminous Re-tread Top	117	20	2	5,000

The uncompleted state highway work carried over to 1928 included 50 miles of concrete and 8 miles of bituminous macadam. The construction program for 1928 includes 225 miles of concrete.

William J. Titus is Chief Engineer Indiana State Highway Commission.

Illinois

During 1927 there were completed under the direction of the Division of Highways of the State Department of Public Works 520.58 miles of paving on the state highway system and 130.31 miles of county paving. The total expenditure during 1927 was $25,600,000,

of which $22,900,000 was for the construction of the state highway system and $2,700,000 for maintenance.

For 1928 it is proposed to build in the state bond road system about 1,150 miles of paving, 400 miles of heavy grading and 171 large bridges at an estimated cost of $42,000,000. Twenty-six counties expect to build under state jurisdiction with their share of the state gasoline tax and county highway taxes 450 miles of paving, 100 miles of heavy grading and 50 bridges at an estimated cost of $15,000,000.

Frank T. Sheets, Springfield, Ill., is Chief State Highway Engineer.

Wisconsin

During 1927 over 1,274 miles of state highway work was completed in Wisconsin. This work included 391 miles of 18 and 20 ft., 6½ in. and 9 in. concrete road at an average cost of $30,180 per mile; 189 miles of crushed stone surfacing at an average cost of $3,100 per mile; 550 miles of 24 ft. and 26 ft. gravel road, 6½ in. center, 3 in. edge, at an average cost of $4,210, 127 miles of graded and drained road at an average cost of $6,050 per mile and 16 miles of shale road at an average cost of $12,100 per mile.

It is rather difficult at this time to give an outline of the 1928 work but it will in all probability run about the same as in 1927. County boards are now in session and information relative to their plans will not be available for some weeks. The total concrete road program in 1927 amounted to about 390 miles as there is about 17 miles of hold over work from the previous year. In addition 12 or 14 miles of concrete road was constructed by day labor.

The accompanying tabulation gives some unit costs on the 1927 work.

H. J. Kuelling, Madison, Wis., is State Highway Engineer.

Michigan

The following mileage of state highways had been completed in 1927 up to Nov. 10:

	Miles	Width Ft.
Cement Concrete	214	20
Bituminous Concrete	24	18
Macadam	3	16
Gravel	67	16

State highway construction carried over to 1928 in projects on which work already had been started was as follows: Cement concrete, 63 miles; bituminous concrete, 24 miles; gravel roads, 69 miles.

It is not possible at this time to outline the program for 1928.

Frank F. Rogers, Lansing, Mich., is State Highway Commissioner.

West North Central States

Minnesota

Over 800 miles of state highway were completed in Minnesota in 1927. This work included 107.8 miles of 7:9:7 18 ft. wide reinforced concrete pavement at an average cost of $24,747 per mile, 343.4 miles of 24 ft. gravel road at an average cost of $2,209 per mile and 356.8 miles of graded and drained road, 30 and 40 ft. wide at an average cost of $11,378 per mile. The new highway work proposed for 1928 is as follows:

Type	Miles	Probable Expenditure
Grading	242.6	$3,275,000
Gravelling	300	662,745
Paving	107.2	2,894,000

C. M. Babcock, St. Paul, Minn., is State Highway Commissioner.

Amount and Unit Costs of Highway Construction in Wisconsin in 1927

Item	Federal Aid Amount	Federal Aid Unit Cost	State and County Aid Amount	State and County Aid Unit Cost
Grading 1, 2.				
Clearing	270.3 Acres	$53.90	155.9 Acres	$53.70
Grubbing	311.7 Acres	70.30	123.3 Acres	99.50
Earth Excavation	1,979,764 Cu. Yd.	0.476	2,665,002 Cu. Yd.	0.49
Loose Rock	93,901 Cu. Yd.	0.81	94,556 Cu. Yd.	0.98
Solid Rock	30,579 Cu. Yd.	1.73	92,225 Cu. Yd.	1.60
Borrow	154,368 Cu. Yd	0.46	89,643 Cu. Yd.	0.53
Channel Change	18,175 Cu. Yd.	0.66	29,621 Cu. Yd.	0.48
Stone Piles	5,984 Cu. Yd.	0.86	4,720 Cu. Yd.	1.22
Intercepting Ditches	98,394 Lin. Ft.	0.036	133,915 Lin. Ft.	0.031
Off-Take and Outlet Ditches	32,250 Cu. Yd.	0.50	8,374 Cu. Yd.	0.67
Bank Protection	126,302 Sq. Yd.	0.0725	176,651	0.019
SURFACING				
Shoulders	10,222 Lin. Ft.	$ 0.25	19,104 Lin. Ft.	$ 0.14
Portland Cement Concrete Surfacing	1,842,792 Sq. Yd.	1.99[3]	2,066,225 Sq. Yd.	2.03[4]
Widening—Concrete Surface			29,257 Sq. Yd.	2.05[5]
Expansion Joints	8,634	3.17	12,558	2.78
Widening—Expansion Joints			161	3.19
Crushed Stone Surfacing	17,325 Cu. Yd.	2.43[6]	161,563 Cu. Yd.	2.19[7]
Gravel [8 9]	183,761 Cu. Yd.	1.00[10]	281,526	1.40[11]
Miscellaneous Surfacing				
Shale[12]	19,808 Cu. Yd.	$ 1.44	39,409 Cu. Yd.	$ 1.22
Top Soil	12,200 Cu. Yd.	0.82	1,282 Cu. Yd.	2.25
Minimum Tailings			1,500 Cu. Yd.	0.77
Concrete				
Conc. A.—6 ft. to 20 ft. Span	3640.5 Cu. Yd.	$24.60	5,356 Cu. Yd.	$25.60
Conc. A.—20 ft. Span and Over	3080.6 Cu. Yd.	26.20	25,950 Cu. Yd.	22.70
Concrete Balusters	448	2.50	3,891	2.72
Conc. A.—Under 6 ft. Span	4984 Cu. Yd.	24.30	6,485 Cu. Yd.	26.14
Steel				
Structural	651,180 Lb.	$ 0.061	2,428,400 Lb.	$ 0.058
Cast	39,205 Lb.	0.153	188,025 Lb.	0.116
Reinforcing	326,097 Lb.	0.045	2,113,101 Lb.	0.043

[1] Federal Aid mileage is 251.2.
[2] State and County Aid mileage is 388.4.
[3] 154.69 miles at $23,700 a mile.
[4] 183.6 miles at $22,800 a mile.
[5] 6.92 miles.
[6] 4.94 miles at $8,510 a mile.
[7] 131.7 miles at $2,680 a mile.
[8] Federal Aid mileage is 38.19.
[9] State and County Aid mileage is 219.3 at $1,790 a mile for loading.
[10] $4,840 per mile for Federal Aid work.
[11] $1,790 per mile on State and County Aid work.
[12] 8.44 miles Federal Aid, 20.99 miles State and County Aid.

Missouri

Nearly 900 miles of state hignway work was completed in Missouri in 1927, up to December 1. This work included 77 miles of 9 ft. concrete, 147 miles of 18 ft. concrete, 399 miles of gravel road and 355 miles of road graded and drained. The costs of the 1927 work are given in the accompanying table:

Missouri State Highway Completed in 1927

Type	Miles	Average Width Surfaced Ft.	Thickness In.	Average Cost Per Mile
Plain Concrete	77	9	6	$15,000
Plain Concrete	147	18	6	33,000
Comb. 9 ft. Conc. and 7 ft. Gravel	16	16	*	26,000
Gravel	399	18	2	10,000
Graded and Drained	356	30	....	14,000

*9 ft. concrete 6 in. thick; 7 ft. gravel 2 in. thick.

The probable expenditures in 1928 for new state highway work amounts to $9,000,000 and calls for the construction of 112 miles of concrete road, 198 miles of gravel and 412 miles of graded and drained road.

T. H. Cutler, Jefferson City, Mo., is Chief Engineer State Highway Department.

North Dakota

In 1927 the state highway work completed in North Dakota included 450 miles of 18 ft. gravel road at an average cost of $1,800 per mile and 575 miles of graded and drained road, 24 ft. wide, at an average cost of $3,800 per mile.

The uncompleted state highway work carried over to 1928 included 546 miles of earth road for which $1,200,000 approximate balance is to be paid, and 140 miles of gravel road requiring a probable expenditure of $200,000.

The construction program for 1928 calls for 525 miles earth road at a probable expenditure of $2,100,000, and 525 miles of gravel road at a probable expenditure of $1,100,000.

The average unit prices bid on the main items of the 1927 work were as follows:

Earth excavation	$00.32 per cu. yd.
Overhaul	.015 per cu. yd. sta.
Wire rope guardrail	.60 per cu. ft.
Wood guard posts	1.00 each
Class A concrete	25.00 per yd.
Reinforcing steel	.065 per lb.
Preparing subgrade for gravel surfacing	75.00 per mile
Load, unload, compact and maintaining	.23 per cu. yd.
Gravel hauling	.17 per cu. yd. mile
Screening	.03 per cu. yd.

H. C. Frahm, Bismarck, N. Dak., is Chief Engineer State Highway Department.

South Dakota

The state highway work completed in South Dakota in 1927 comprised 3.12 miles reinforced concrete, 20 ft. wide and 7 in. thick at an average cost of $30,000 per mile, 275 miles of 24 ft. wide, 7 in. thick gravel road at an average cost of $5,000 per mile and 217 miles of graded and drained road, 24

ft. wide, at an average cost of $3,200 per mile.

The incomplete state highway work carried over to 1928 included 3.69 miles of reinforced concrete at a probable expenditure of $110,000; 200 miles of gravel road, $360,000; and 200 miles graded and drained, $640,000.

The new state highway work proposed for 1928 is as follows:

Type	Miles	Probable Expenditure
Reinforced concrete	10	$300,000.00
Gravel	200	360,000.00
Graded and drained	200	640,000.00

J. Maughs Brown, Pierre, S. Dak., is State Highway Engineer.

Maryland State Highway Work Completed in 1927

Type	Miles	Average Width Surfaced Feet	Thickness In.	Average Cost Per Mile
Plain concrete	73.23	15	6-8-6	$30,500
Sheet asphalt	5.87	40	6 base, 3 asph.	127,000
Macadam	6.67	15	8	16,000
Gravel	19.69	15	8	9,000
Concrete shoulders	89.96	3*	8	10,500

*Each side of existing roadway.

Nebraska

During 1927 the State Bureau of Roads completed 610 miles of grading, 1,410 miles of gravel road and 8.6 miles of pavement, the total cost being $6,500,000. For 1928 it is estimated that 200 miles of grading and 500 miles of gravel road will be constructed at an approximate cost of $2,000,000.

R. J. Boyd, Lincoln, Neb., is Chief Engineer, Bureau of Roads.

Kansas

This state completed approximately 500 miles of road in 1927 at a cost of $6,000,000. For 1928 it is probable 800 miles will be built at a cost of $8,000,000.

W. V. Buck, Topeka, Kan., is State Highway Engineer.

South Atlantic States

Delaware

The state highway work completed in Delaware in 1927 included 29.9 miles of plain concrete, 17 miles of 4 ft. concrete widening and 7.9 miles of 20 ft. widening. The accompanying table gives some details of the work:

Delaware State Highway Work Completed in 1927

Type	Miles	Aver. Width Surfaced Ft.	Thick. In.	Average Cost Per Mile
Plain concrete	22.6	14 to 20	6 to 8	$23,000 to $36,000
Plain concrete	7.3	9	6	$14,000
4 ft. widening concrete	17.0	4	8	8,000
20 ft. widening concrete sidewalks, also sewers	7.9	20	9	80,000
Macadam	3.5	12	6	8,000
Sand-asphalt	5.13	14	6	22,000
Oiling macadam graded and drained	8.0	12	..	1,000

The incompleted work carried over to 1928 included 13 miles of 9 ft. plain concrete requiring a probable expenditure of $180,000; 2.5 miles of 20 ft. widening of concrete, including sewers and sidewalks, to cost $185,000; 2.8 miles of 16 ft. plain concrete.

The 1928 program for new work calls for 50 miles of plain concrete at a probable expenditure of $1,000,000, 20 miles of widening, $200,000; and 5 miles of other types at a probable cost of $50,000.

C. D. Buck, Dover, Del., is State Highway Engineer.

Maryland

The state highway work completed in Maryland in 1927 included 73.23 miles of plain concrete, 5.87 miles of sheet asphalt, 6.67 miles of macadam, 19.69 miles of gravel and 89.96 miles of concrete shoulders. The accompanying tabulation gives some details of this work:

The incompleted state highway work carried over to 1928 was as follows:

Type	Miles	Prob. Expenditure
Concrete shoulders	8.41	$ 88,305
Plain concrete	45.31	1,381,955
Macadam	4.27	68,320
Gravel	15.63	140,670
Asphalt	1.63	207,010

The new state highway work proposed for 1928 is shown in the accompanying table:

	Miles	Prob. Expenditure
Plain concrete	75.0	$2,287,500
Macadam	15.0	240,000
Gravel	30.0	270,000
Concrete shoulders	100.0	1,050,000
Sheet asphalt	5.0	635,000

The average unit bidding price on some of the items entering into the 1927 construction were: excavation, 86 ct. per cubic yd; concrete surfacing, $1.70 per sq. yd. (cement furnished by State Roads Commission) and concrete shoulders, $2.17 per sq. yd. (cement furnished by State Roads Commission and price bid including excavation.)

John N. Mackall, Baltimore, Md., is Chairman and Chief Engineer of State Roads Commission.

Virginia

During the fiscal year ending June 30, 1927, a total of 233 miles of state roads were completed, the cost being as follows:

Type	Miles	Cost
Concrete	73.952	$2,600,489
Bituminous macadam	84.882	2,780,288
Surface treated macadam	29.250	841,615
Loose stone macadam	.670	4,247
Slag	1.970	46,279
Top soil	30.923	279,486
Sand clay	.....	.....
Graded and drained	11.292	265,269
Total	232.939	$6,817,675

In addition to the above 11.7 miles of widening concrete surfacing were completed at a total cost of $195,601. The reconstruction and resurfacing completed during the above period included 434 miles of widening and oiling at a cost of $1,303,527, and bridges and masonry involving a cost of $463,027. The work under construction on June 30, 1927, was as follows:

Type	Miles	Contract or Allocation	Paid to June 30, 1927
Concrete	121	$4,781,435	$1,933,126
Bituminous macadam	78	2,913,610	2,095,547
Surface treated macadam	.....	.....	.....
Gravel	45	907,811	525,752
Top soil	19	277,912	158,576
Graded and drained	110	2,146,338	1,041,084
Miscellaneous	.....	6,000	4,319
Total	376	$11,033,109	$5,758,405
Betterments	.....	.....	.....
Widening and oiling	322	965,774	490,768
Bridges	.....	1,721,170	822,908
Other masonry	.....	37,073	97
Grand total	.....	$13,757,126	$7,072,180

Henry G. Shirley, Richmond, Va., is State Highway Commissioner.

West Virginia

Over 900 miles of state highway work were completed in West Virginia in 1927. This included 66.65 miles of plain concrete, 97 miles of bituminous macadam and 320.79 miles of gravel roads. The accompany table gives some details of the 1927 work. The average prices per mile include the cost of grading and draining which averages $15,000 per mile.

West Virginia State Highway Work Completed in 1927

Type	Miles	Aver. width Surfaced ft.	Thickness In. Aver. cost	per mile
Plain concrete	66.65	16	7	$43,000
Bituminous macadam	97.09	16	11	37,000
Gravel	320.79	16	8	20,000
Graded and drained	373.54	26	..	15,000
Stone base	43.75	16	8	27,000

The incompleted state highway work carried over to 1928 included 11.1 miles of gravel requiring a probable expenditure of $55,500; 21.1 miles bituminous macadam, $464,200; 17.47 miles concrete, $489,160; 101.78 miles grading and draining, $1,526,700 and 20.12 miles stone base, $241,440.

The construction program for 1928 has not been decided definitely but it probably will involve an expenditure of $3,000,000. The work of making connections on main routes will probably continue.

The average unit prices on the 1927 work were as follows:

Unclassified excavation	70c per cu. yd.
Concrete pavement	$14.50 cu. yd.
Class A concrete	$20.00
Class B concrete	18.00
Stone base	$5.00 cu. yd.
Top for bituminous macadam roads	75c sq. yd.
Oil asphalt applied	18c per gal.
Tar applied	20c per gal.
Wire cable guard rail	60c ft.

C. P. Fortney, Charleston, W. Va., is Chairman, State Highway Commission.

North Carolina

During 1927 a total of 1,338 miles of state highway work were completed. This includes 453 miles of concrete, 226 miles of gravel, top soil and sand clay, 68 miles of sand asphalt and 31 miles of bituminous concrete. Details are given in the accompanying tabulation:

North Carolina State Highway Work Completed in 1927

Type	Miles	Average Width Surfaced, Ft.	Thickness, In.	Average Cost Per Mile
Plain Concrete†	453.79	16 & 18	8-6-8	$25,000
Bituminous Macadam	8.80	16 & 18	8†	7,700
Bituminous Concrete	31.32	16 & 18	7††	27,000
Macadam	27.84	16	8	14,000
Gravel, Top Soil and Sand and Clay	226.81	30-35	9	9,000
Sand-Asphalt	68.93	18	5††	17,000
Graded and Drained	314.26	30-35	.....	8,500
Road Oil Treatment	206.29	.....	.....	5,200

North Carolina State Highway Work Completed in 1927

†8-6-8 also in 6 in. uniform. †8 in., 2 layers. ††5 in. base, 2 in top. ††3 in. base, 2 in. top.

The incompleted work carried over to 1928 included 43.9 miles of concrete, 27.17 miles of sand asphalt, 72.96 miles of top soil, sand-clay and gravel and 125 miles graded road.

The new state highway work proposed for 1928 includes 350 miles of hard surface pavement involving a probable expenditure of $7,500,000, and 800 miles of other types of road involving a probable expenditure of $7,500,000.

L. R. Ames, Raleigh, N. C., is State Highway Engineer.

South Carolina

During 1927 the State Highway Department of South Carolina let to contract 530 miles of hard surfaced roads of various types at an estimated cost of $14,500,000, about 290 miles of earth type roads at an estimated cost of $2,000,000, and bridge work estimated to cost $1,000,000.

Approximately 511 miles of improved roads were completed in 1927, of which 235 miles are of hard surface construction at a cost of $6,082,000, 275 miles are of improved earth type construction at a cost of $1,790,000, and bridge work at a cost of approximately $1,500,000. Of the hard surface construction, 186 miles are of plain concrete, 18 ft. wide, with an average thickness of 6½ and 7 in., 34 miles of sheet asphalt either with a 5 in. concrete base and 1½ in. binder and 1½ in. sheet asphalt top, and 15 miles of asphaltic concrete with a 5 in. concrete base and a 2 in. asphaltic concrete surfacing.

Funds are now available for 1928 construction, in addition to contracts under way, of approximately 300 miles of hard surface roads, and 100 miles of improved earth type roads. It is probable that by April additional funds will be made available for more paving work, increasing the total mileage to be let to contract beyond that for 1927.

Unit prices bid on concrete pavements varied considerably during the year, depending on the average haul on the project, the location of the road, the availability of the local materials, and the constant drop in the price of cement, and a decrease in freight rates. The average has been between $2 and $2.10 per square yard for concrete pavement, and the unit price on common excavation has varied, but as an average is around 30 ct. to 35 ct. per cubic yard.

Chas. H. Moorefield, Columbia, S. C., is State Highway Engineer.

Georgia

During 1927 a total of 397 miles of state highway was completed at a cost of $7,840,938. The work under construction carried over to 1928 amounted to 1,226 miles, the estimated cost being $19,978,880. The program for 1928 construction has not been completed yet.

W. R. Neel, East Point, Ga., is State Highway Engineer.

Florida

Between Jan. 1, 1927 and Dec. 15, 1927, the State Road Department of Florida let contracts for 725 miles of road improvement. The following table shows the mileages of the various types and their cost:

Grading, 354.65 miles	$ 2,866,231
Rock base surface treated, 236.64 miles	3,580,584
Bituminous Concrete, 25.1 miles	744,678
Sheet Asphalt, 35.8 miles	1,021,242
Bituminous Macadam, 20 5 miles	565,334
Plain Cement Concrete, 52.41 miles	1,663,557
Bridges, 22,371 feet	3,515,353
Total contracts	$13,926,983

The above represents the work put under construction in 1927.

The following mileages had been completed up to Oct. 25, 1927: 105.05 miles of concrete, 22.49 miles of bituminous concrete, 15.51 miles of sheet asphalt, 238.61 miles of rock base, 11.72 miles of sand-clay and 11.15 miles of bituminous macadam. In the month of October there was built approximately 39 miles of road and it was expected that November and December will equal October, which will give a total of 482 miles of road built in 1927. The bridge work is estimated at from 15,000 to 18,000 ft.

The expenditures including construction, maintenance and administration to December amounted to $20,292,951.

The budget for 1928 has not yet been prepared, but it is expected that the resources will be around $17,000,000.

J. L. Cresap, Tallahassee, Fla., is State Highway Engineer.

East North Central States

Kentucky

During 1927 the work constructed under the direction of the Kentucky State Highway Department included 421 miles graded and drained road and a considerable mileage of reconstruction of low type roads. The total expenditure for construction during the year was approximately $10,000,000. About 490 miles of incompleted road were carried over to 1928. New projects will be awarded which will make the construction for 1928 equal in mileage and expenditures to the 1927 program.

E. N. Todd, Frankfort, Ky., is State Highway Engineer.

Alabama

The beginning of the year 1927 saw the last of the first $25,000,000.00 road bond issue obligated by road and bridge contracts. When the present administration came into office there were no funds available for new construction, therefore the highway commission was forced to mark time until funds were received from an additional bond issue of $25,000,000.00. This second bond issue was ordered submitted to the people of Alabama by a special session of the legislature during December, 1926, and was ratified by a large majority of the voters on April 12th. In the meantime plans were being prepared from surveys completed under the former highway commission and new surveys authorized and placed under way with the result that when funds became available in August of this year the highway commission was able to begin asking for bids on a large volume of road and bridge construction. Beginning with the August lettings and including those in December the highway department has placed under contract 808.0 miles of highway construction including the necessary bridges and culverts. The total value of these contracts is $7,957,544.00.

The above mileage is divided into 226 miles of paving; 236 miles of gravel or chert, 141 miles of sand-clay and 205 miles of grading and draining, or stage construction. It is the plan of the department to maintain this volume of construction during 1928.

Woolsey Finnell. Montgomery, Ala., is State Highway Director.

Mississippi

The state highways completed in Mississippi in 1927 included 59 miles of plain concrete and 90 miles of gravel road. Some details of last year's work are given in the accompanying table.

Mississippi State Highway Completed in 1927

Type	Miles	Aver. width surfaced ft.	Thickness In.	Aver. cost per mile
Brick	5	18	—	$43,000
Plain concrete	59	18	9-6-9	25,000
Gravel	90	16, 18	6*	15,000
Graded and drained	66	24,26 c	..	5,000

*Compacted.

The incompleted state highway work carried over to 1928 included 95 miles of graded road requiring a probable expenditure of $500,000 and 95 miles of gravel road requiring a probable expenditure of $1,400,000.

The new state highway work proposed for 1928 is as follows:

Type	Miles	Prob. Expenditure
Graded	75	$ 400,000
Gravel	40	600,000
Plain concrete	60	1,500,000

H. C. Dietzer, Jackson, Miss., is State Highway Engineer.

West South Central States

Arkansas

The work completed in 1927 under the direction of the State Highway Commission included 115 miles of gravel roads, 10 miles of concrete, 28 miles grading and drainage structures, concrete bridges 469 ft., steel and concrete bridges 250 ft., timber bridges 1,798 ft. The total cost was $1,700,000.

The contracts awarded in 1927 called for the construction of 700 miles of grade and drainage structures, 350 miles gravel road, 50 miles concrete road, 10 miles asphalt road, 4,130 ft. timber bridges, 10,285 ft. concrete bridges, 3,870 ft. steel bridges. The estimated cost is $11,000,000.

The proposed program for 1928 includes 600 miles grade and drainage structures, 1,450 miles gravel road, 375 miles concrete and 25 miles asphalt. The estimated cost is $18,000,000.

C. S. Christian, Little Rock, Ark., is State Highway Engineer.

Oklahoma

The accompanying tabulation shows the state highway work completed in Oklahoma in 1927:

Oklahoma State Highway Completed in 1927

Type	Miles	Average Width Surfaced Ft.	Thickness In.	Average Cost Per Mile
Brick	0.935	18	7¾	$30,000
Plain Concrete	108.03	18	6	23,000
Graded and Drained	385	30		5,500
Rock Asphalt on Concrete Base	23.53	18	7	27,000

The incompleted work carried over to 1928 comprised 15 miles of plain concrete involving a probable expenditure of $345,000. The construction program for 1928 will be approximately the same as in 1927.

Clark R. Mandigo, Oklahoma City, Okla., is State Highway Engineer.

Texas

During 1927 a total of 962.7 miles of highway was completed at a cost of $12,501,464. The following table shows the types and their cost:

Summary of Completed Projects in 1927

Type	Mileage	Cost
Concrete Pavement	107.51	$ 2,923,510
Bituminous	364.25	4,558,380
Gravel, Iron Ore Soil or Macadam	76.48	1,022,764
Shell, Caliche or Sand Clay	25.02	186,687
Grading and Drainage Strc.	389.45	2,648,752
Bridges	16	1,161,368
Total	962.71	$12,501,464

The above figures show only the actual work done during 1927, and in a number of cases the cost of the bituminous and concrete surfacing include only the actual surfacing and do not include any grading or drainage structures.

The following table summarizes the projects under construction on Nov. 1:

Summary of Projects Under Construction

Type	Mileage	Cost
Concrete pavement	206.82	$5,957,979
Bituminous	39.29	563,919
Gravel, Iron Ore or Macadam	25.83	60,548
Shell, Caliche, Sand Clay	18.19	58,416
Grading and Drainage Strc.	321.95	2,149,631
Bridges	11	880,634
Total	612.08	$9,671,130

For 1928 it is intended to construct approximately the same number of miles as was built in 1927, but it is believed that the mileage of higher types of construction will be materially increased.

R. A. Thompson, Austin, Tex., is State Highway Engineer.

Mountain States

Idaho

A total of 390 miles of state highway was completed in Idaho in 1927. The cost of this work is shown in the table.

Idaho State Highway Completed in 1927

	Miles	Width	Average Thickness	Average cost per mile
Plain concrete	1.14	18	9-6-9	$26,281
Bitum. concrete	12.99	18	6	24,257
Macadam	233.7	18	5	11,057
Graded and drained	69.9	24	..	3,243
Oil treated macadam	72	18	2	2,017

The incompleted work carried over to 1928 included 15.5 miles 18 ft. wide, 8 in. thick bituminous macadam, to cost $250,000, and 89.12 miles 18 ft. wide, 5 in. thick macadam, to cost $979,000. The construction program for 1928 provides for 340 miles of oil macadam estimated to cost $780,000; 5.5 miles paving, $165,000; and 134 miles grading and surfacing, $1,300,000.

The 1927 average unit prices on Idaho state highway construction were as follows:

Solid rock excavation	$1.11	per cu. yd.
Loose rock excavation	.51	per cu. yd.
Earth excavation	.32	per cu. yd.
Unclassified excavation	.463	per cu. yd.
Concrete class A	$27.55	
Metal reinforcing	$0.074	per lb.
Crushed gravel or rock surfacing	$1.748	per cu. yd.
Surfacing binders	.53	per cu. yd.
Rip rap loose	1.31	per cu. yd.
Rip rap hand placed	4.13	per cu. yd.
Guard rail	.896	per cu. yd.
Haul on surface and binder	.222	per mi. yd.
Unload-haul and place 12 G.I.P.	$0.36	per ft.
18 G.I.P.	.47	per ft.
24 G.I.P.	.62	per ft.
30 G.I.P.	.77	per ft.
36 G.I.P.	.67	per ft.

J. D. Wood, Boise, Idaho, is State Commissioner of Public Works.

Montana

State highway work completed in Montana in 1927 comprised 1.03 miles of 20 ft. wide, 6½ in. thick concrete pavement at an average cost of $47,000 per mile; 162 miles of 16 ft. wide, 6½ in. thick gravel road at an average cost of $10,100 per mile, and 47 miles of graded and drained road at an average cost of $9,500 per mile.

The incompleted state highway work carried over to 1928 included 42 miles of graded road involving a probable expenditure of $346,000 and 98 miles of gravel road, involving an expenditure of $1,090,000.

The program for new state highway work for 1928 calls for the construction of 225 miles of gravel road at a probable expenditure of $2,250,000.

R. D. Rader, Helena, Mont., is State Highway Engineer.

Wyoming

The state highway work placed under contract in 1927 in Wyoming included 1.1 mile, 20-40 ft. wide, 6 in. thick concrete pavement at an average cost of $65,000 per mile, 164 miles of 18 ft. wide 6 in. thick gravel road at an average cost of $4,500 per mile, and 210 miles of graded and drained road at an average cost of $7,000 per mile.

The new state highway work proposed for 1928 includes 200 miles of earth road at a probable expenditure of $1,300,000 and 180 miles of gravel road at a probable expenditure of $720,000.

Z. E. Sevison, Cheyenne, Wyo., is state highway engineer.

Colorado

The total mileage of state highways completed in Colorado in 1927 was 250 to 300 miles, involving a construction expenditure of about $3,120,000. Construction expenditure in 1928 probably will be 50 per cent to 75 per cent in excess of that in 1927.

L. D. Blauvelt, Denver, Colo., is State Highway Engineer.

New Mexico

State highway work (Federal Aid projects only) completed in New Mexico in 1927 comprised 1.1 miles of 18 ft. concrete road, 6 in. center, 8 in. edges, at an average cost per mile of $37,639; 154.5 miles of 16 ft. or 18 ft. 8 in. (loose) gravel road at an average cost of $10,844 per mile, and 63.3 miles of graded and drained roads at an average cost of $7,193 per mile.

The incompleted state highway work

(Federal Aid projects only) carried over to 1928 included 103.2 miles of gravel road, probable expenditure $930,000, and 8.6 miles concrete road, probable expenditure $357,000.

A rough estimate of the new highway work proposed for 1928 shows the following:

	Miles	Probable Expenditure
Concrete	2	$ 65,000
Gravel roads and graded and drained roads	200	3,000,000

The following tabulation shows the average contract prices on 1927 work of the New Mexico State Highway Department:

Average Contract Prices, 1927, New Mexico State Highway Department

	Price
Common Excavation, Cu. Yd.	$ 0.22
Rock Excavation, Cu. Yd.	1.50
Borrow, Cu. Yd.	0.22
Overhaul, Sta. Yd.	0.03
Gravel Surfacing, Cu. Yd.	1.59
Crushed Rock Surfacing, Cu. Yd.	2.76
Mortar Rubble Masonry, Cu. Yd.	15.00
Riprap, Cu. Yd.	6.00
24-in. Diameter Corr. Metal Culvert, Lin. Ft.	2.83
30-in. Diameter Corr. Metal Culvert, Lin. Ft.	3.53
36-in. Diameter Corr. Metal Culvert, Lin. Ft.	5.00
Class "A" Concrete, Cu. Yd.	22.00
Class "B" Concrete, Cu. Yd.	23.00
Cement Concrete Pavement, Cu. Yd.	16.75
Asphalt Expansion Joint, Lin. Ft.	0.15
Reinforcing Steel, Lb.	0.08
Woven Wire Guard Fence, Lin. Ft.	0.97
Plating, Cu. Yd.	0.55
Spillway Base Course, Cu. Yd.	3.55
Clearing and Grubbing, Acre	14.00
Moving Fence, Lin. Ft.	0.02
Federal Markers, Each	12.75
Ditch and Dike, Lin. Ft.	0.05
Creosoted Timber (Box Culverts), M. B. M.	155.00
Creosoted Timber (Superstructure), M. B. M.	165.00
Creosoted Timber (Substructure), M. B. M.	165.00
Creosoted Timber Piles, Lin. Ft.	1.70
Bridge Excavation, Cu. Yd.	2.00
Asphalt Wearing Surface, Sq. Yd.	0.90

W. C. Davidson, Santa Fe, New Mexico, is State Highway Engineer.

Arizona

The state highway work completed in Arizona during the fiscal year June 30, 1926-1927, amounted to 116.8 miles of which 64.32 miles were gravel surfaced roads and 38 miles were graded and drained. In addition 9.5 miles of bituminous macadam, 4 miles of bituminous concrete and 1 mile of plain concrete were completed. These pavements were 18 ft. and 6 ft. thick. The concrete cost $25,000 per mile.

The program for the remainder of the fiscal year ending June 30, 1928, calls for the expenditure of $5,654,487 for construction and improvement of state highways. The revenue provided for in the budget is to be derived from the ten mill property tax, direct appropriation, the four cent gas tax, motor vehicle and motor title fees, proclamation and special appropriations, Federal Aid and municipal and railroad participation. Federal Aid participation for the present fiscal year aggregates $2,367,581. This year the construction program calls for 355.8 miles of highways, with surveys of 281.74 miles of surveys and eight bridges totaling in length 3,400 ft.

W. W. Lane, Phoenix, Ariz., is chief engineer, State Highway Department.

Nevada

The accompanying tabulation gives some details of the state highway work completed in Nevada in 1927.

Nevada State Highway Completed in 1927

	Miles	Average Width Surfaced Ft.	Thickness In.	Average Cost Per Mile
Plain Concrete	3.92	18	7-5-7	$30,330
Gravel and Crushed Rock	98.49	15	6½	7,364
Gravel Surface only	15.50	18	6½	3,991
Oiled Gravel, Turnover method	4.76	18	3 Pen.	2,105

The incompleted state highway work carried over to 1928 and the probable expenditures are as follows: Crushed rock and gravel, 60 miles, $480,000; graded and drained, 9.46 miles, $236,000; widening present roadway and surface 46.25 miles, $132,000.

The new state highway work proposed for 1928 is as follows:

Type	Miles	Probable Expenditure
Crushed Rock or Gravel	84	$600,000
Widening Present Roadway Oiled Gravel. Turnover Method	125	227,500
One Conc. and Steel Grade Separation		50,000
and Surface	125	312,500

The accompanying table shows the unit bidding prices in 1927 on state highway work:

Average Unit Prices Bid on Nevada Contracts for Year of 1927

Items	Average Price Bid
Excavation Unclassified	0.49 Cu. Yd.
Overhaul	0.02 Yd. Sta.
Prepare Subgrade and Shoulders	107.22 Miles
Excavation—Type 1	0.80 Cu. Yd.
Excavation—Type 2	0.26 Cu. Yd.
Crushed Gravel Surface in Place	1.36 Cu. Yd.
Class "A" Concrete	35.43 Cu. Yd.
Class "B" Concrete	36.72 Cu. Yd.
15 in. C.M.P. f.o.b. nearest siding	0.96 Lin. Ft.
18 in. C.M.P. f.o.b. nearest siding	1.11 Lin. Ft.
24 in. C.M.P. f.o.b. nearest siding	1.66 Lin. Ft.
30 in. C.M.P. f.o.b. nearest siding	2.11 Lin. Ft.
36 in. C.M.P. f.o.b. nearest siding	2.53 Lin. Ft.
18 in. Vitrified Pipe in place	3.00 Lin. Ft.
24 in. Vitrified Pipe in place	5.00 Lin. Ft.
Cement Rubble Masonry	16.00 Cu. Yd.
Monuments	3.72 Each
Timber complete in place	150.00 M. Ft. B. M.
Treated Timber Piles	2.00 Lin. Ft.
Furnishing Watering Equipment	650.00 Lump Sum
Applying Water	1.83 M. Gal.
Rip Rap	4.70 Cu. Yd.
Prepare grade for Selected Material for Subbase and Shoulders	50.00 Miles
Prepare Subgrade and Shoulders — 9 ft. pavement	1,650.00 Miles
Prepare Subgrade and Shoulders—18 ft. pavement	2,835.00 Miles
Cement Concrete Pavement	0.96 Sq. Yd.
Erecting Woven Wire Guard Fence	0.82 Lin. Ft.
Selected Material for Subbase and Shoulders complete in place	0.65 Cu. Yd.
Remove and Reset Fence	0.06 Lin. Ft.
Structure Excavation	2.50 Cu. Yd.
Structural Steel in place	0.075 Lbs.
Steel Reinforcement in place	0.06 Lbs.
Installing 15 in. C.M.P.	0.75 Lin. Ft.
Installing 18 in. C.M.P.	0.79 Lin. Ft.
Installing 24 in. C.M.P.	0.79 Lin. Ft.
Installing 30 in. C.M.P.	1.43 Lin. Ft.
Installing 36 in. C.M.P.	1.25 Lin. Ft.
Hand Placed Rock Fill	5.25 Cu. Yd.
Clearing Right of Way	100.00 Acres
Widening Present Roadway	240.00 Lin. Mi.
Widening Present Surface	70.00 Lin. Mi.
Pipe Culvert Extensions	10.00 Each
18 in. C.M.P. in place	1.89 Lin. Ft.
24 in. C.M.P. in place	2.50 Lin. Ft.
30 in. C.M.P. in place	3.26 Lin. Ft.
36 in. C.M.P. in place	4.00 Lin. Ft.

S. C. Durkee, Carson City, Nev., is State Highway Engineer.

Utah

The state highway work completed in Utah in 1927 approximates 100 miles of reconstructed roads, of which 4 miles is concrete resurfacing to a width of 20 ft. The cost of the latter work was something less than $30,000 per mile. Gravel roads cost approximately $12,000 per mile. About $500,000 worth of incompleted work was carried over to 1928.

The program for 1928 calls for the expenditure of $1,500,000 for construction. About 100 miles of gravel road will be built.

H. S. Kerr, Salt Lake City, Utah, is Chief Engineer, State Road Commission.

Pacific States

Oregon

The accompanying table shows the state highway work completed in Oregon in 1927:

Oregon State Highway Completed in 1927

Type	Miles	Average Width Surfaced Ft.	Thickness In.	Average Cost Per Mile
Brick				
Plain Concrete	0.9	18	7	$35,000
Reinforced Concrete				
Bituminous Macadam				
Bituminous Concrete	0.2	18	6	30,000
Sheet Asphalt				
Macadam				
Gravel or Broken Stone Surf	138.3	18	8	7,000
Sand—Asphalt				
Graded and Drained	79.4	24 Rdbed.		15,000
Oiling Surfacing	383.5	18	....	900

The incompleted work carried over to 1928 included 46 miles of broken stone or gravel surfacing requiring a probable expenditure of $325,000, and 65 miles of grading to cost about $975,000.

The new state highway work proposed for 1928 is as follows:

Type	Miles	Probable Expenditure
Surfacing	40	$280,000
Grading	40	600,000
Oiling Surfacing	380	350,000

The above figures are only roughly approximate as the state highway commission has not yet definitely ordered the work which is to be placed under contract.

Roy A. Klein, Salem, Ore., is State Highway Engineer.

California

The accompanying tabulation gives some details of the state highway work completed in California in 1927:

California State Highway Work Completed in 1927.

Type	Miles	Average Width Surfaced Ft.	Thickness In.	Average Cost Per Mile
Plain Concrete and Reinforced Concrete	41.0	20-40	9-6-9	$47,613
Bituminous Macadam	12.7	20-24	6-7	23,828
Asphalt Concrete and Surface P. C. C. Base	50.2	15-20	1½-4	20,513
Graded and Rock Surfacing	46.9	20-24	*4-8	25,154
Graded and Drained	11.8	24-30		19,038

*Includes work of placing additional and temporary surfacing.

The incompleted state highway work carried over to 1928 included 38.1 miles of portland cement concrete requiring a probable expenditure of $1,925,000, 35.1 miles of asphaltic concrete surface on portland cement base, requiring a probable expenditure of $913,000; 9.7 miles of bituminous macadam requiring a probable expenditure of $540,000 and 105.1 miles of grading and graveling requiring a probable expenditure of $2,350,000.

The construction program for 1928 has not been completed at this time.

The average unit cost of the various items entering into construction during 1927 were as follows:

Grading	57 ct. per cu. yd.
Portland cement concrete pavement	$10.48 per cu. yd.
Asphalt concrete pavement	$5.08 per ton

R. M. Morton, Sacramento, Calif., is State Highway Engineer.

Federal Aid Road Construction

Federal aid road projects completed during the fiscal year ending June 30, 1927, increased by more than 8,300 miles, the mileage of improved roads in the Federal aid highway system, and brought the total length of roads improved with Federal assistance up to 64,209 miles, the chief of the Bureau of Public Roads, Thos. H. MacDonald says in his annual report to Secretary of Agriculture Jardine, made public on Dec. 10. The Bureau of Public Roads also cooperated with the state highway departments in secondary improvements necessitated by increased traffic on 1,376 miles. Independently for the most part, it completed construction of 453 miles of main highways in the National Forests; and at the request of the National Park Service the bureau surveyed and supervised the construction of important roads in the national parks and monuments, among them a number which will give access to hitherto unapproachable beauty spots of the national domain.

Federal payments during the year amounted to $81,371,013.03 or about $6,000,000 less than the disbursement of the previous year which in turn was $8,000,000 lower than the year before. "It may be expected," Mr. MacDonald comments, "that the annual expenditure will be still further reduced in the future until—the accumulated balances of earlier appropriation being expended—the program of expenditure reaches the rate set by the annual authorization of $75,000,000 of recent years.

"The annual highway bill of the country," the report continues, "is in excess of a billion dollars, including all expenditures of the Federal, State and County and other local governments, for construction, maintenance and administration. Of this amount the Federal expenditure is less than 8 per cent, and the states alone spent, of their own funds, more than six times the amount they recieved from the Federal Government. It is apparent, therefore, that the Federal expenditure, at the current rate, is not extravagant, but is, in fact, extremely moderate in view of the large and growing interstate traffic.

"The largest disbursements during the year were made to Missouri, New York and Texas. To each of these states the Federal Government paid more than $4,000,000. Pennsylvania received more than $3,000,000 and all other states less than that sum.

"In proportion to the total mileage of the several geographic divisions, the Federal aid disbursement in 1927 was greatest in the Middle Atlantic States and least in the West South Central States. On this basis the first of these groups received more than twice as much as the second, and between these two extremes the other areas, ranked in descending order, were as follows: New England, South Atlantic, Pacific, East North Central, East South Central, West North Central and Mountain.

"That the offer of Federal aid has not induced the states to make expeditures in excess of those they would otherwise have made is indicated by the fact that in 1926 every state, with two exceptions only, (Montana and North Dakota) made expenditures, some very large, in addition to those for Federal aid roads, the total of such additional expenditures being $452,798,000, or more than four times the amount spent to match Federal aid."

Cooperating with the states, the bureau completed the selection of the principal transcontinental roads which will form the United States highway system, and on which uniform signs and markers are to be erected by the states. It also practically completed the distribution to state highway departments of the surplus war material, and retains only a comparatively small quantity of explosives which will be distributed this year.

"Equalling, if not transcending, in value the service directly rendered in the construction of roads," Mr. MacDonald believes that "the researches of the bureau have made available to engineers more exact knowledge of the fundamentals of highway design and economics. Of special importance are the studies of the magnitude and effects of the impact of heavy motor trucks upon highway surfaces, and the possibility of reducing the intensity of the impact forces by changes in the spring, wheel, and tire equipment, and by refinement in the surfaces of roads." Other important studies dealt with soils and road surfaces, transport and traffic surveys, efficiency studies in the operations of road building, and the testing of materials and designs.

The Federal aid highway system now includes more than 185,000 miles of road, about one-third of which has been improved with Federal assistance. With the exception of about 7,500 miles, all the 64,000 miles have been improved in the last six years. "The number of motor vehicles," Mr. MacDonald observes, "continues to increase annually at an approximately constant rate. The registration of 1926 was more than twice that of 1921, the year in which the Federal aid system was designed, and the traffic served by the roads was, of course, increased proportionately. It is necessary, therefore, not only to extend the improved mileage, but also gradually to raise the type of improvement on the roads already constructed."

The aggregate length of the bridges more than 20 ft. long built during the year was 45.9 miles, which was more than twice the bridge mileage of the preceding year. A bridge, more than two miles in length, spans the Choctawhatchee River in Florida between Westville and Caryville. Two, each more than a mile in length were completed, one over the White River between Bedford and Mitchell in Indiana and the other over the Platte River in Nebraska.

Roadside Footpaths.—Footpaths for pedestrians parallelling the motor highways of Ontario as a safety measure to reduce casualties to walkers and to increase the speed of automobiles on roads were advocated by Hon. George S. Henry, minister of highways in a plan presented to the provincial legislature.

Evaluation of Sands for Sheet Asphalt Pavements

How Good Idea of Relative Suitability of Different Sands May be Obtained by Stability Test Described in Paper Presented Nov. 29 at 6th Annual Asphalt Paving Conference

By PREVOST HUBBARD and F. C. FIELD
Chemical Engineer and Chemist, The Asphalt Association

What is a good sheet asphalt sand? The obvious answer is, any sand that can be combined with mineral filler and asphalt to produce a strong dense weather resistant and stable sheet asphalt paving mixture. However, if the value of a given sand has not been demonstrated by a long period of satisfactory use, how may its suitability or unsuitability be determined prior to use? Comparison of certain of its characteristics with sands of demonstrated value may be of assistance in answering this question but two sands are seldom if ever exact duplicates and sands taken from different parts of the same deposit may vary materially from time to time. Of what importance then are variations from the known characteristics of sands of demonstrated suitability?

What Specifications Require.—Most approved specifications require that a sheet asphalt sand shall consist of clean tough, rough surfaced angular grains, be free from clayey lumps and foreign matter and have a mesh composition within certain defined percentage limits. Visual inspection, with perhaps the aid of a magnifying glass or microscope, will determine whether or not the grains are clean and free from coatings and whether or not clayey lumps or foreign matter are present. Surface texture and angularity are easily observed but difficult to classify in many cases owing to variations in such properties shown by the different size grains of the same sand. What is the importance of such variations which cannot be classified on a comparable basis? No method has as yet been devised for determining the relative toughness of sand grains and it is probable that individual grains in the same sand vary greatly in this property. What is the significance of such variation which cannot be ascertained or even approximately estimated in most cases. Mesh composition may be determined with considerable accuracy by passing the sand through a series of standard sieves but even within the specified limits, which of necessity must be rather wide, what is the significance of observed variations in grading? Certain ideal gradings are sometimes established with the idea of securing a sand which will duplicate this grading as closely as possible. Exact duplication is practically impossible but it may be found that a number of sands are available for a given job which approach the ideal but differ from it in different respects. Granted that the so called ideal is really ideal, which of the available sands approaching it in mesh composition is the best for use? These question are at present difficult and often impossible to answer definitely and the authors do not propose to even attempt to answer them. Certain data will be introduced however, to illustrate how difficult it is to evaluate a sand merely by the ascertainable characteristics of the sand itself and how it may be possible to obtain a good idea of the relative suitability of different sands by

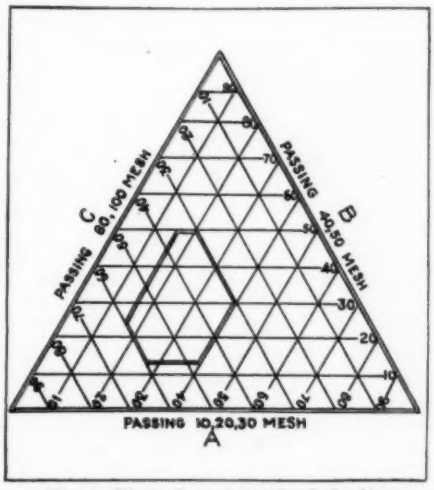


Fig. 1—Three Component Sand Grading

means of the stability test applied to paving mixtures in which such sands are incorporated.

The stability test consists in measuring the resistence to displacement or interval movement of a sample of compressed paving mixture. Such resistance is recorded in pounds pressure required to start internal movement under certain defined conditions of test. The corrolation of this test to the past and probable future behavior of paving mixtures under traffic was covered in a paper presented at the 1926 Asphalt Paving Conference. Before discussing an investigation of its usefulness in evaluating sands, certain preliminary studies of individual sands in connection with their mesh composition and combination with mineral filler will be presented.

Relation of Voids to Mesh Composition.—The relation of voids to mesh composition has been the subject of numerous investigations and gradings apparently producing a minimum of voids have been used to construct so called curves of maximum density. In specifications for sheet asphalt sands no attempt is usually made to specify limits for, or control the percentage of voids except perhaps indirectly in establishing an ideal grading which is to be duplicated as closely as possible. Voids in the sand and total mineral aggregate have however, been recognized as factors of considerable importance and their significance has been discussed by numerous investigators almost since the inception of the modern asphalt pavement many years ago.

No very satisfactory method has as yet been devised for determining the percentage of voids in sheet asphalt aggregates so as to reasonably sure of duplicating the arrangement and closeness of packing of the individual grains as they exist in a properly proportioned and well compacted paving mixture. A method has however been devised by the authors which give values somewhat higher than but closely related to the closness of packing of the mineral aggregate in paving mixtures. This method known as the kerosene method was used in the preliminary study of relation of grading to voids.

Three Component Sand Grading.—If an asphalt sand is separated by means of sieves into three groups each composed of different size grains and the weight percentage of each group is ascertained, the mesh composition of the sand may be plotted as a single point on a triaxial diagram. Figure 1 shows such a diagram with dots indicating different gradings, well distributed over its area. The small enclosed six sided area is bounded by lines representing customary specification limits for the mesh composition of sheet asphalt sands. In starting the grading-void study a large sample of sand widely used in New York and vicinity was first separated into the three groups shown on the diagram, Group A Coarse, passing the 10 and retained on the 40 mesh sieve, Group B, Intermediate, passing the 40 and retained on 80 mesh sieve and Group C, fine, passing the 80 and retained on the 200 mesh sieve. Portions of these groups were next combined to produce 22 samples of different grading corresponding with the dots on the diagram.

The percentage of voids in each of these sands was next determined and from the results obtained it was found possible to develop lines or contours, each line indicating roughly a given percentage of voids. Such contours are shown in Fig. 2. Here it is seen that

the lowest percentage of voids was found to exist in a small area representing a sand composed of about 75 percent coarse particles, little or no intermediate particles and about 25 percent of fine particles. The curved lines representing higher voids are roughly concentric with the low void area, the highest percentage of voids being found

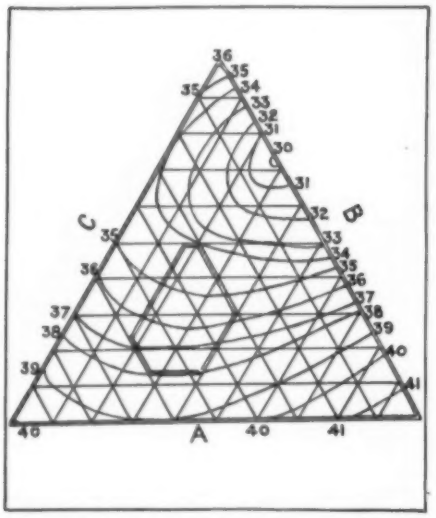


Fig. 2—Relation of Voids to Three Component Sand Grading

in sands composed entirely of fine particles or entirely of intermediate particles. It may be noted that the general relations here shown are very similar to those developed as early as 1892 by Feret who adopted a somewhat different grouping of sand grains for use with the triaxial diagram. The same general relations have also been developed in recent independent work not yet published by Emmons who adopted the same group subdivisions but worked with a sand of entirely different origin. It should be particularly noted that the specifications area on this diagram while it apparently eliminates the highest void sands, does not include any of the relatively low void sands. It should also be noted however, that the mesh composition producing the lowest voids is seldom, if ever met by a single natural sand and that when this grading is artificially created the absence of intermediate particles creates a strong tendency toward segregation and therefore lack of uniformity.

Effect of Intermediate Grading of Voids in Sands.—The relations so far established on the basis of group grading were obtained on sands in which the composition of each of the three groups remained a constant, but what effect will variations in grading within any one or all three of the groups produce on the voids in the sand? Some idea regarding this subject may be obtained from Fig. 3 in which four sands of definite group gradings are plotted. The figures near each point show percentage of voids as affected by variations in intermediate gradings. In the coarse sand (1) a variation of nearly six percent of voids has been produced by varying the intermediate grading of the Group A. Only small differences in voids have been produced by varying the intermediate gradings in the uniformly medium and fine sands (2) and (3) but a difference of nearly 4 percent voids has been developed by varying the intermediate grading of a centrally located sand coming within the specification area. Moreover it will be noted that while the lowest percentage of voids has been developed by a certain combination in sand (1) a variation in intermediate grading has produced a higher percentage of voids than that shown by a certain combination in sand (4). This then upsets the general deductions drawn from the preceeding figure except for cases in which the comparison is made between sands in which the mesh composition of each group remains a constant.

Even where such constants maintain, the general deductions regarding relation of voids to mesh composition of the sand, may be radically altered when the sands are mixed with mineral filler and the voids are determined on the total mineral aggregate. This is illustrated in Fig. 4 where the mesh composition of the sands is the same as for Figs. 1 and 2 but the void contours are plotted from determinations made on combinations of these sands with 20 and 40 percent respectively of a given commercial limestone filler. In the diagram at the left will be observed a certain similarity of the contours shown in Fig. 2. In the diagram at the right however, it is apparent that the relationships have become radically altered and a number of independent low void areas have been created. Had some other commercial filler been used it is only reasonable to suppose that still different relationships would have been developed.

Factors Bearing on Relation Between Grading and Void.—The data so far presented illustrates that the relations between grading and voids is so involved that no accurate forecast of percentage of voids in a sheet asphalt aggregate can be deduced from the known mesh composition of the sand. There are other important factors bearing upon these relations such as shape and surface texture of grain which will be discussed later but it can be said here that while it may be possible to determine by an elaborate series of experiments some particular mesh composition which will produce the lowest percentage of voids with a given sand, it is impossible to select an ideal grading or to construct a curve of maximum density which is applicable to all sands as used in combination with ordinary commercial fillers to produce mineral aggregate for sheet asphalt. With due apologies to all previous investigators, and their painstaking work it is the authors convictions that "there ain't no such animal." Certain additional information on this subject will be developed in connection with a discussion of the use of the stability test as a means of evaluating sands.

Before making a stability test the specific gravity of the compressed test specimen of asphalt paving mixture is first determined. In determining the maximum stability that can be secured from a given mineral aggregate a number of test specimens containing different percentages of a given asphalt are prepared and tested. The specific gravity of these mixtures of course vary with the percentage of asphalt and the closeness of packing of the mineral aggregate. If the specific gravity and percentage weight of each constituent of the mix are known it is possible to calculate with considerable accuracy the apparent density or closeness of packing of the mineral aggregate and to express the results as voids in the mineral aggregate irrespective of the asphalt which may partially fill or completely fill them. Voids determined in this manner will hereafter be termed V. M. A. to distinguish them from the voids in the total paving mixture which are not filled with asphalt. By varying the percentage of asphalt with a given aggregate it becomes possible to determine not only maximum stability but maximum practical closeness of packing of the mineral aggregate or minimum practical V. M. A.

Sands Used in Investigation.—In carrying out this investigation it was considered highly desirable to work with a wide variety of sand. Authentic samples of typical asphalt sands were therefore first secured and included such products as pit sand used in New York City, Potomac river sand used in Washington, D. C., Lake Erie sand as used in Columbus, Lake Michigan sand as used in Chicago, Platte river sand as used in Omaha, beach sands from Florida and Long Island

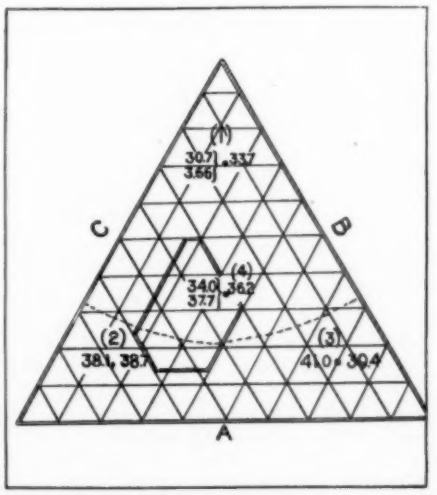


Fig. 3—Effect of Intermediate Grading on Voids in Sand

and a number of sands from other sources. All of the gradings were natural with the exception of those from Florida and Platte river which were mixed products, the latter being prepared to duplicate the so called ideal heavy traffic grading so widely used as a standard.

Each of these sands was combined with a single commercial limestone filler to produce aggregates containing

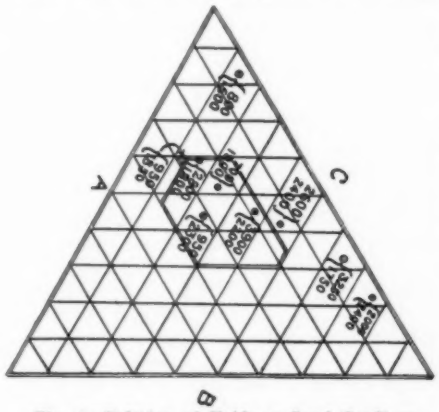


Fig. 4—Relation of Voids to Sand Gradings

10, 20, 30 and 40 percent of filler. As 79 percent of the filler passed a 200 mesh sieve the percentage of 200 mesh filler in the final mixtures containing asphalt amounted to approximately 7, 14½, 22 and 29 percent for the respective series. Each of the mineral aggregates was combined with not less than 3 different percentages of 40 to 50 penetration asphalt in preparing specimens for the specific gravity and stability tests.

In order to determine what effect might be produced by variations in shape and texture of grain a large sample of the New York sand was separated into seven sizes by means of the usual standard sieves and as exact a duplicate as possible was prepared of each of the sands obtained from other sources. These duplicate sands were mixed with filler and asphalt to produce duplicates of all of the other mixtures. Over 325 individual mixtures were thus prepared and tested in duplicate and in a few cases, where the checks were not reasonably close or the results were questionable, new mixtures were prepared and tested.

Sand Gradings.—To present and discuss all of the results at this time is unnecessary and impracticable but some of the data will be used to illustrate the facts which are believed to be of most importance. First of all to return to grading and voids, the mesh composition of a so called ideal sand and other sands which produced the minimum and maximum V. M. A. for each of the filler series is shown in Table I with the corresponding V. M. A. of the duplicate produced with New York sand. First of all it will be seen that the so called ideal grading did not produce the lowest V. M. A. in any of

Table I

Sand Number	Sand Grading A	B	C	Filler in Mineral Aggreg. 10%	20%	30%
8 Ideal				24.3	20.9	19.2
N. Y. Dupl.	26	43	31	27.7	23.7	21.7
14				22.2	19.4	17.5
N. Y. Dupl.	32	44	24	27.7	22.8	20.5
26				30.8		
N. Y. Dupl.	12	83	5	31.5		
18					26.3	22.2
N. Y. Dupl.	14	58	28		26.3	23.6

the filler series. The somewhat coarser but well graded sand No. 14 developed the lowest V. M. A. but the duplicate of this grading with the New York sand using 10 percent filler showed the same V. M. A. as the ideal grading with this same sand. Confirming the previously reported results a relatively high V. M. A. was obtained with sands in which the B group of particles greatly predominated. It is of particular interest to note that in every comparison the New York sand showed a higher V. M. A. than the sand which it was intended to duplicate, thus indicating an appreciable influence produced by some other factor than mesh composition. A difference of 5½ percent voids was found between Sand 14 with 10 percent filler and its New York duplicate. An examination of these sands under the microscope showed both to be fairly rough surfaced but the New York sand was somewhat sharper and more angular in its coarse and intermediate size grains. The visual difference between these two sands would not however, lead one to believe that with the same mesh composition a difference of over 5 percent voids would be developed.

Relation of Stability to Grading.—The relative stability values developed by Sand 14 and its New York duplicate may be of interest to note at this point. With 10 percent filler both showed good stability but Sand 14 was somewhat higher than its duplicate. Further additions of filler however, produced practically no increase in stability with Sand 14 although the V. M. A. were reduced. On the other hand the stability of the New York duplicate was materially increased by the further addition of filler and with 20 percent filler in the mineral aggregate the New York duplicate developed over 1,000 lbs. greater stability than Sand 14.

That the V. M. A. per se has no dependable relation to stability was shown by a study of maximum stability values developed by all of the mineral aggregates. It was observed that while there is a general upward trend in stability with decrease in voids for the low percent filler series, the higher percent filler series were extremely erratic and if anything tended to show the reverse.

That grading per se cannot be depended upon to fortell the relative stability of asphalt mixtures produced by sands of known mesh composition is illustrated by Figs. 5 and 6. In Fig. 5 a few of the stability values obtained with sands of varying mesh composition mixed with 10 percent filler are shown on the triaxial diagram. Each set of figures in brackets shows the stability produced by a given sand and by its New York sand duplicate of the same mesh composition. A difference of over 100 percent is seen to exist between certain sands and their New York sand duplicates. It will be further noted that while the highest stability value is located within the customary specification area the same is true of the lowest stability value. On the other hand relatively high stability values have been developed by a number of sands entirely outside of the specification area. As a matter of interest it may be noted that the same facts were developed by a similar comparison of the 20 and 30 percent filler series, and confirm the results reported by the authors three years ago in their first experiments with Castor Oil mixtures, before they had developed their stability test to a point where it could be reliably used in studying mixtures containing asphalt.

Figure 6 is of interest in further illustrating the lack of definite relations existing between mesh composition of different sands and the V. M. A. and stability developed by their use in asphalt paving mixtures in which the mineral aggregate contained 10 and 20 percent of filler. The solid curve shows the so called ideal grading and the broken line curve, a grading entirely different. The two sets of values given for the ideal grading represent two different sands of identically the same mesh composition.

Relative Stability Values.—Having shown that there are no relations between mesh composition voids and stability sufficiently definite to enable one to forecast from grading and void tests whether or not a given sand will pro-

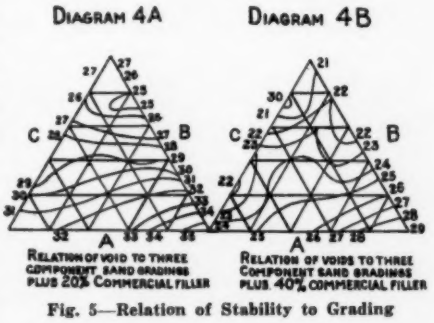


Fig. 5—Relation of Stability to Grading

duce a stable mixture it will be instructive to study some typical differences in stability which are developed by sands which have been and are now being used in sheet asphalt construction in different parts of the country. For this comparison four sands have been selected namely New York sand, Potamac River sand, Platte River sand and a Florida sand. Stability values of the New York sand regarded to dupli-

cate the other sands have also been included as shown in Table II.

Examination of the table reveals some interesting information. First, it will be noted that the New York and Potomac River sands possess relatively high stability while the Platte River and Florida sands show low stability.

Table II Relative Stability Value of Sands

Sand	Sand Grading A	B	C	Filler in Mineral Aggreg. 10% Pass. 200 Mesh in Mix 7%	20% 14.5%	30% 22%
1 New York	27	60	13	1,700	3,800	4,000
10 Potomac				3,900	4,600	5,500
N. Y. Dupl.	38	43	19	2,200	3,400	4,100
8 Platte Riv.				950	1,600	2,200
N. Y. Dupl.	26	43	31	2,300	3,600	4,300
24 Florida				700	1,200	2,000
N. Y. Dupl.	24	53	23	1,900	3,000	3,900

Mesh composition cannot be held responsible for the observed differences as in every case duplication of the Platte River and Florida gradings with New York sand developed relatively high stability. That the Potomac River sand has an inherently higher stability than the New York sand is shown by the lower values produced by the latter when it was made to duplicate the grading of the former. With a relatively low percentage of 200 mesh filler it is seen that the natural New York sand develops less than half the stability of the Potomac River sand but over twice that of the Florida sand. Similar differences are seen to exist when other percentages of filler are present. Although the ratios are not exactly the same. The Potomac River sand with 7 percent of 200 mesh filler in the mix is seen to produce a much more stable mixture than either the Platte River or Florida sands with 22 percent of the same 200 mesh filler, and about the same as that shown by the New York sand with 14.5 percent of 200 mesh filler. On the other hand the New York sand with 7 percent 200 mesh filler in the mix develops about the same stability as the Platte River sand with 14.5 percent 200 mesh filler.

The causes of most of these observed differences remains a matter of speculation and probably always will as they are undoubtedly the complex results of differences in grading, voids, shape of grains, surface area, and surface texture which are so interwoven as to make it almost impossible to evaluate them separately.

The Surface Texture Factor.—That surface texture is a factor of considerable importance in connection with stability, is indicated by the much rougher surface of the Potomac River sand than of the Florida sand, but there appears to be no such difference between the New York and Florida sands. Nearly a hundred micro-photographs were made of the sands used in this investigation with the hope that some definite relations might be developed between surface texture, angularity, and stability but the results were in general disappointing. Platte River sand is composed mainly of relatively round and smooth surfaced grains which could logically be considered to be the cause of its low stability value. On the other hand the apparent difference in texture and angularity between the New York and Florida sands could hardly be interpreted to indicate their wide differences instability value found by test.

If time permitted it might be interesting to develop what the stability test is able to show about the asphalt carrying capacity of different sands and the relation of surface area to this characteristic. It is believed however, that enough has been presented to show

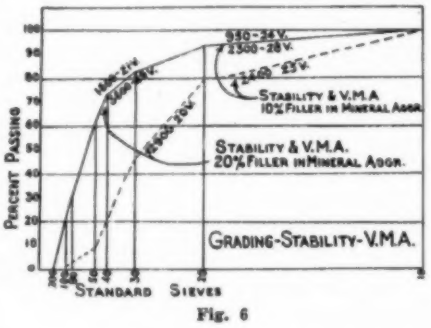


Fig. 6

that if the inherent resistance of an asphalt paving mixture to internal movement is an important characteristic, and it is believed that few if any will question this proposition, then by means of the stability test it is possible to evaluate sands for sheet asphalt pavements, more completely and readily than by any or all of the usual tests and requirements to which such sands have been subjected in the past. It should be realized however, that such evaluation is dependent to a great extent upon the character and proportions of the mineral filler and asphalt which are to be associated with the sand in the finished mixture. As an illustration while the Florida sand developed a very low stability until combined with as high as 30 percent of a given limestone filler it was found possible by using another readily available filler in considerably less amount materially increase the stability of mixtures in which it was used.

Problem Localized.—The problem of evaluating a sand by means of the stability test therefore, becomes localized and it is believed that when so treated many sands which have heretofore been considered unsuitable may be found entirely satisfactory for use in sheet asphalt construction. To illustrate by a specific example, two local sands may be readily available for use on a given job. Let us suppose that Sand A which is considerably cheaper than sand B does not exactly meet the usual specifications for mesh composition but it is clean and reasonably shary and rough. Sand B falls within the specifications limits but is smoother and the grains are more rounded in character. Let us also suppose that two mineral fillers X and Y are locally available at approximately the same price. Upon making up trial mixtures of these sands with filler and asphalt it may be found that Sand A with 15 percent of filler Y produces as high a stability as Sand B with 25 percent of either of the fillers and that the sand A mixture will also carry the highest percentage of asphalt without loss in stability. If the voids in both compressed mixtures are satisfactorily low it is evident that the use of Sand A is to be preferred not only from the standpoint of producing the most highly weather resistant mixture but also because of its probably greater economy.

Numerous other hypothetical examples might be cited to illustrate the serviceability of the stability test in evaluating sand but time does not permit. The authors have found it particularly useful in utilizing a single available sand to best advantage when the sand was not of the most satisfactory character. In such cases the problem becomes one of selecting the most suitable filler and consistency of asphalt for use with this sand to produce a mixture of satisfactory stability.

In conclusion it should be said that when evaluating a paving mixture by means of this stability test the percentage of voids in the total compressed mixture should be given consideration and, other things being equal, preference should be given to that mixture which carries the highest percentage of asphalt and shows the lowest percentage of voids when thoroughly compressed. By so doing, greater insurance will be obtained against weathering disintegration and cracking.

Low Interest Rate on Highway Loan

Setting a new record low rate interest for highway notes, Tennessee's new state administration last November disposed of a $1,000,000 short term loan at an interest rate of three and one-half per cent. This is believed to be the first time that a loan of this kind has been obtained for less than four per cent.

The sale was negotiated by Albert Williams, new commissioner of finance and taxation, with the National Park bank, of New York. Proceeds of the transaction, authorized by the 1927 general assembly, will be used entirely for highway construction.

Inquiry into the marketing of Southern securities recently reveals that Alabama sold $3,000,000 securities at 4.25 per cent interest and later $2,000,000 at 4 per cent.

Arkansas' best record is given as 4.21 per cent; Mississippi as 4.13, and North Carolina as 4 per cent.

Heavy Grading for Future State Highway

Contractor's Methods on Clearing and Grubbing Heavy Hardwood Stand—Making Heavy Cuts and Fills With Elevating Graders and Teams—Making Large Cut With Gas Shovel —The Construction Camp

The typical heavy grading job on new right of way through heavy stands of hardwoods and through more open country containing hills, meadows and wet flats, is exemplified by the work now being done by the J. J. Dunnegan Construction Co., for the State of Illinois, near Palos Park, Illinois. Because of the way in which the work is handled, the conditions facing the contractor on the job, and the efficiency of the organization, the methods which were observed on the job will prove of general interest.—The Editor.

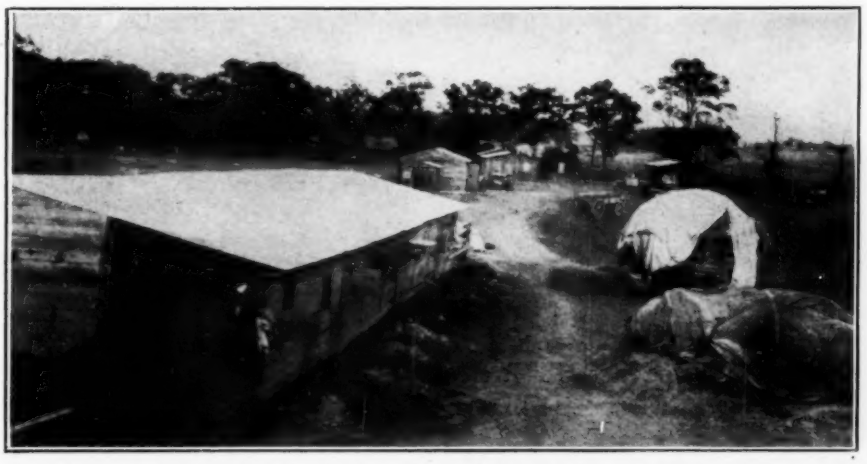


Fig. 1—View of Camp, With Barn in Foreground, Blacksmith Shop in Left Center, Two Bunk Houses at Left Rear, and Mess Shack at Right Rear

Approximately five miles of heavy grading had to be done through an oak forest and through hilly open country that proved to contain a number of peat bogs, in order that a new state highway could be later paved in the State of Illinois. Due to the fact that the route lay in new right-of-way, the only work to be done in 1927 consisted of clearing and grubbing, disposing of stumps, brush, and logs, and the making of the cuts and fills. After seasoning for a couple of years, a concrete pavement may be laid.

The route passes through a hilly region noted for its scenic value and largely forested with a heavy stand of burr oak timber. Cuts and fills are heavy for this section of the country and most balance points required considerable overhaul. The soil consists mostly of yellow clay, very hard and lumpy when dry. At several places pockets of fine yellow sand were encountered, some of which were wet and quakey. A few cuts showed a buckshot clay which crumbled readily. The whole area was spotted with boulders from 6 in. in diameter to 24 in. in diameter.

Total Excavation.—Excavation totaled 135,000 cu. yd. with one cut alone accounting for 37,000 yd. On account of the distance of the job from the surrounding towns, two camps were established for the care of the men and teams.

One camp, located near two of the heaviest cuts, consisted of two bunk houses, mess shack, blacksmith shop and barn, all sectional buildings. This camp provided accommodations for one elevating grader outfit, the clearing gang, and one culvert gang.

The other camp was located about

Fig. 2—The First Step in the Clearing Is to Fell the Trees. Here the Timber Gang Is Slashing an Oak That Was Forgotten on the Preliminary Clearing in the Large Cut on Which the Gas Shovel Was Used. The Team Will Drag the Trunk Out of the Way

Fig. 3—The Stumps Are Pulled by Machine and Are Left Like This for the Powder Gang, Which Then Blows Off the Dirt and Splits the Stumps for Burning. Supt. McDaniel, Right, Is Showing the Root System of a Big One

two miles from the first, near another heavy cut, and consisted of a portable cook shack, two sectional bunk houses, and a sectional barn. It furnished accommodations for one elevating grader crew and one culvert gang. The larger camp was lighted with a Westinghouse electric light plant, which also furnished power for the shop. Coleman gas lamps were used in the smaller camp. The mess shacks were equipped with portable tables, each seating eight men, and the bunk houses were equipped with steel double bunks and army blankets.

Fig 4—The Powder Gang Leaves the Way Looking Somewhat Like This. After a Bit of Picking Up and Burning the Ground Is Ready for the Grader Gang. Here McDaniel Is Showing Grading Foreman Sullivan Where His Fill Is Supposed to Come. Stumps in Foreground Will Be Cut to Grade

Fig. 5—This Team and Skinner Is Half the Cleanup Crew That Drags Out the Stumps and the Logs. The Near Mule Is a Rare Black That Is Worth Two of the Ordinary Animals When it Comes to Moving the Heavy Oak Logs. His Teammate, While the Best That Could Be Found, Hasn't Nearly His Strength

Fig. 6—The Sloper at Work on a Heavy Cut, Here Checking for Specified Slope

Clearing and Grubbing.—The right of way between slope stakes contained approximately 1,350 trees varying in size from 8 in. in diameter to 36 in. in diameter with an estimated average of 14 in. at the stump. These had to be felled, the brush and stumps burned, and the trunks piled along the right of way. Stumps up to 14 in. in diameter were pulled with a Hercules Stump Puller, operated by two men and a team. Larger stumps were blown with Hercules 30 per cent and 40 per cent dynamite. After the smaller stumps were pulled 1 or 1½ sticks of dynamite were placed in the dirt clinging to the roots which when fired blowed the dirt off and split the stump enough so that a man and team could easily get it onto a pile to be burned.

The organization consisted of five men felling, trimming and burning brush; team snaking out trunks and piling stumps; 2 men and team pulling stumps; and one powder man. This crew, using 150 lb. of dynamite and 50 caps averaged about 40 trees per nine hour day.

Grading.—Two elevating grader outfits were being used, one working from each camp. Each outfit consisted of a Caterpillar tractor, elevating grader, 10—3 up Stroud 1½-yd. wagons, a mormon and a blade grader. Teams were interchanged between the outfits somewhat, due to the lengths of haul. Both tractors, a Holt 10-ton and a Best 60, had seen a lot of service but were still very much on the job. Two men with each outfit were necessary to remove the boulders from the cuts and to do the backsloping. The backsloping was done with mattocks and long handled spades, the slope being checked with a device shown in one of the illustrations.

A Shovel Cut.—A cut of 37,000 yd. presented special difficulties. Here the right of way followed a deep and crooked ravine down a steep bluff. The grade of the ravine was about 7 per cent and the side slopes from 20 per cent to 50 per cent. Due to the crookedness of the ravine, the centerline of the roadway crossed it twice, making about 700 ft. of side hill cutting. The final grade of the roadway is to be 5 per cent. A ¾-yd. Northwest shovel was started at the upper end of the ravine and worked its way down one slope by casting into the ravine until it reached the first fill section. It then started a cut up the slope on an approximate 9 per cent grade. Dump trucks were used to haul the dirt down to the fill and by back dumping down the ravine, a road was made to the flat bottom at the foot of the bluff.

The cut on the west side of the ravine

is only about 150 ft. long and the top of the slope is 25 ft. above grade. After the ravine had been filled by the trucks, the shovel was moved to the west side and started digging down the ravine but on an upgrade into the slope. When it reached the end of the cut, it turned, and up the ravine and upgrade again into the slope. By making a third zig-zag cut the shovel was able to reach the slope stakes at the top, without cutting into the final slope. As the shovel was brought down the final sloping was completed. When the first cut up the ravine was completed, the trucks were replaced for hauling, with teams as the trucks proved inefficient when the dirt was at all wet.

Those Responsible. — This work is being done for the State of Illinois, represented by the State Highway Department, by the J. J. Donnegan Construction Company. J. R. McDaniel is superintendent in active charge.

Fig. 7—Top—Grading Outfit Working on Big Cut in Clay Filled With Large Stones. The Dump Is on the Fill to the Right. Fig. 8—Next Below—View of the Fill, Where a Mormon Was Used to Push the Clay Over the Edge. Fig. 9—Bottom—Closeup Showing Elevating Grader Making a Good Cut

Fig. 10—Top—The Gas Shovel Is Digging Its way toward the slope stakes in the heavy cut. Supt. McDaniel Is Telling the Foreman "Good Work." Note the Oak Timbers Used to Support the Crawlers and to Keep the Shovel From Going Down Hill. Fig. 11—Bottom—Another View of Same Operation Showing Cut and Cast Method Used

Reducing Losses of Trees in Roadside Planting.—The Board of County Road Commissioners of Wayne County, Michigan, requires that for two years or more all trees planted alongside the roads be regularly watered, mulched and sprayed until a healthy growth is obtained in the new environment. In this way the losses of trees are reduced to a minimum.

Contractors to Meet at Spokane.—The annual convention of the Pacific Northwest Branch of the Associated General Contractors of America will be held Feb. 10 and 11 at Spokane, Wash.

Estimating Data for Highway Bridges

Data derived from actual cost records are used by the Bridge Department of the Illinois Division of Highways in preparing its estimate for highway bridges. We are indebted to G. F. Burch, Bridge Engineer of the Division for the following particulars.

Method of Finding Unit Estimating Prices for Structural and Reinforcing Steel

Trusses.—Assume 100 ft. Span. Weight 86,620 lb. Material: Either Mill or Warehouse Price or half of each depending on supply and demand. Use current price for beams, channels, angles and plates. Freight: For mill price use C. L. price from Pittsburgh to Springfield plus C. L. price from Chicago to Springfield. For warehouse price use twice C. L. price from Chicago to Springfield. Shop Work: Base of $0.70 per 100 lb. with 40 cent labor. This includes shop coat of paint at $1.50 per gallon. Use current prices of shop labor and paint. Falsework and Erection: Base of $11.00 per ton for bolting, placing and falsework with 40 cent labor. For riveting use 1,750 rivets at $0.08 each with 40 cent labor. Use current prices for labor. Paint: Use sheet "Painting New Steel Bridges." Neglect freight. Haul: Assume 3,000 lb. load and 4 trips per day. Use current price of teams. Profit: Use 25 percent.

Plate Girders for Overheads.—Same as "Trusses" except use half of erection cost and five-sixteenths of shop work cost. When gunite is used omit field paint.

I-Beams.—Material: Either mill or warehouse or half of each. Use current price of I-beams. Freight: For mill price use C. L. price from Pittsburgh to Springfield plus L. C. L. price from Chicago to Springfield. For warehouse price use C. L. price Chicago to Springfield plus L. C. L. price Chicago to Springfield. Shop Work: Base of $0.35 per 100 lb. with 40 cent labor. Use current price of labor. Falsework and Erection: Same assumptions as shop work. Paint: Use sheet "Painting New Steel Bridges." Neglect freight. Haul: Assume 3,000 lb. load and 4 trips per day. Use current price of teams. Profit: Use 25 percent.

Reinforcing Steel.—Material: Use current price of ½ in. square bars at either mill or warehouse price or half of each. Freight: For mill price use L. C. L. price from Pittsburgh to Springfield. For warehouse price use L. C. L. price from Chicago to Springfield. Bending and Placing: Use 1 man hour per 100 lb. at current labor price. Haul: 3,000 lb. load and 4 trips per day. Use current price of labor. Profit: Use 35 percent.

Cleaning and Painting Old Steel Bridges

Amount of paint required per ton:

1st coat.....½ gal.
2nd coat.....½ gal.
3rd coat.....½ gal.

For old steel bridges, the weight in pounds may be approximated by formula. $W=L(250+2.5L)$ Where $L=$ span in ft.

Surface area per ton=200 sq. ft.

One man will paint 60 sq. ft. per hour for field costs. (Shop coat 120 sq. ft. per hour.)

Assume: Paint—$1.70 blue; $1.92 tinted per gallon. Labor—$0.45 per hour.

Painting New Steel Bridges

Paint $(\frac{1}{2}+\frac{1}{2}+\frac{1}{2})\times 1.77=$	$2.65
Labor, Shop Coat $1\times\frac{200}{120}\times 0.45=$	.75
Labor, Field Coats $2\times\frac{200}{60}\times 0.45=$	3.00
	$6.40
Profit 25 percent	1.60
Total	$8.00 per ton
	$0.0040 per pound

When making estimates for cost of cofferdams assume that the cofferdam plan dimensions are 2 ft. 6 in. greater in each dimension than the footing.

The bottom of the cofferdam is assumed to extend to a depth of 2 to 4 ft. below the bottom of the footing.

The top of the cofferdam is assumed to extend to a point 2 ft. above the elevation of ordinary water.

The table gives the estimated cost per foot of perimeter of cofferdam. A unit price for a cofferdam is given when the material is used only one time and also a unit price for each additional use of the same material. This latter figure assumes that 25 per cent new material will be required for wood cofferdams and 10 per cent new material for steel cofferdams.

Cost Data on Various Types of Structures

This information has been secured from actual records kept by inspectors on bridge construction and applies to structures designed and built under the supervision of the Division of Highways. The labor items are given in man-hours so that variations in the prices of labor may be readily figured.

Type of Structure	Box Culvert	Slab Bridge	Thru Girder Bridge	Deck Girder Bridge	Plain Concrete Abutments	Arch Open Spandrel	6 inch Concrete Floor
No bridges considered	83	93	48	3	5	1	—
	Man Hours per Cubic Yard of Concrete						
Building Forms	4.24	4.41	4.71	7.04	2.69	14.86	3.07
Mixing & Placing Concrete	3.97	4.65	4.33	3.97	3.45	4.18	6.28
Bending & Placing Steel	0.68	0.75	1.51	1.24	—	5.20	0.31
Excavation	4.22	4.50	5.21	4.17	5.65	4.84	—
	Feet B M per Cubic Yard of Concrete						
Form Lumber	24.20	16.53	17.54	20.23	10.00	47.75	30.70
	Pounds per Cubic Yard of Concrete						
Average Amount of Reinforcing Steel	100	Slab 190 Sub 70	Slab 230 Sub 85	Slab 230 Sub 85	—		100

Cost per Cubic Yard for Form Lumber

On bridges or abutments over 28 ft. from crown to stream bed add 8 to 10 percent to the above figures. (Concrete floors excluded.)

Cost per M B M	Box Culverts	Slab Bridges	Thru Girder Bridges	Deck Girder Bridges	Arch Open Spandrel	P.C. Abut's & Piers	6" Concrete Floor	6" Reinforced Con Floor	R.C. Abut's	R.C. Footings Abut's
$30.00	.73	.50	.53	.61	1.43	.30	.92	1.15	.50	.53
35.00	.85	.58	.61	.71	1.67	.35	1.07	1.34	.58	.61
40.00	.97	.66	.70	.81	1.91	.40	1.23	1.54	.66	.70
45.00	1.09	.74	.79	.91	2.15	.45	1.38	1.73	.74	.79
50.00	1.21	.83	.88	1.01	2.39	.50	1.54	1.92	.83	.88
55.00	1.33	.91	.97	1.11	2.63	.55	1.69	2.11	.91	.97
60.00	1.45	.99	1.05	1.21	2.87	.60	1.84	2.30	.99	1.05
65.00	1.57	1.07	1.14	1.32	3.10	.65	2.00	2.49	1.07	1.14
70.00	1.69	1.16	1.23	1.42	3.34	.70	2.15	2.69	1.16	1.23
75.00	1.81	1.24	1.32	1.52	3.58	.75	2.30	2.88	1.24	1.32
80.00	1.94	1.32	1.40	1.62	3.82	.80	2.46	3.07	1.32	1.40
F.B.M.	24.2	16.53	17.54	20.23	47.75	10.00	30.70			

Cost per Cubic Yard for Mixing and Placing Concrete

Cost of Labor per Hr	Box Culverts	Slab Bridges	Thru Girder Bridges	Deck Girder Bridges	Arch Open Spandrel	P.C. Abut's & Piers	6" Concrete Floor	6" Reinforced Con Floor	R.C. Abut's	R.C. Footings Abut's
$0.25	.99	1.16	1.00	.87	1.04	.86	1.57	1.57	1.16	1.08
0.30	1.19	1.40	1.30	1.16	1.25	1.03	1.88	1.88	1.40	1.30
0.35	1.39	1.63	1.52	1.35	1.46	1.21	2.20	2.20	1.63	1.52
0.40	1.59	1.86	1.73	1.55	1.67	1.38	2.51	2.51	1.86	1.73
0.45	1.79	2.09	1.95	1.73	1.88	1.55	2.83	2.83	2.09	1.95
0.50	1.98	2.32	2.17	1.94	2.09	1.72	3.14	3.14	2.32	2.17
0.55	2.18	2.56	2.38	2.13	2.30	1.90	3.45	3.45	2.56	2.38
0.60	2.38	2.79	2.60	2.32	2.51	2.07	3.77	3.77	2.79	2.60
0.65	2.58	3.02	2.82	2.52	2.72	2.24	4.08	4.08	3.02	2.82
0.70	2.78	3.26	3.03	2.71	2.93	2.42	4.40	4.40	3.26	3.03
0.75	2.98	3.49	3.25	2.90	3.13	2.59	4.71	4.71	3.49	3.25
0.80	3.18	3.72	3.46	3.10	3.34	2.76	5.02	5.02	3.72	3.46
0.85	3.37	3.95	3.68	3.29	3.55	2.93	5.34	5.34	3.95	3.68
Hrs	3.97	4.65	4.33	3.87	4.18	3.45	6.28			

Cost per Cubic Yards for Building Forms

On bridges or abutments over 28 ft. from crown to stream bed add 8 to 10 percent to the above figures. (Concrete excluded.)

Cost of Labor per Hr	Box Culverts	Slab Bridges	Thru Girder Bridges	Deck Girder Bridges	Arch Open Spandrel	P.C. Abut's & Piers	6" Concrete Floor	6" Reinforced Con Floor	R.C. Abut's	R.C. Footings Abut's
$0.25	1.06	1.10	1.18	1.76	3.71	.67	.77	.96	1.10	1.18
0.30	1.27	1.32	1.41	2.11	4.46	.81	.92	1.15	1.32	1.41
0.35	1.48	1.54	1.65	2.46	5.20	.94	1.07	1.34	1.54	1.65
0.40	1.70	1.76	1.88	2.82	5.94	1.08	1.23	1.54	1.76	1.88
0.45	1.91	1.98	2.12	3.17	6.69	1.21	1.38	1.73	1.98	2.12
0.50	2.12	2.20	2.35	3.52	7.43	1.34	1.53	1.92	2.20	2.35
0.55	2.33	2.43	2.59	3.87	8.17	1.48	1.69	2.11	2.43	2.59
0.60	2.54	2.65	2.83	4.22	8.92	1.61	1.84	2.30	2.65	2.83
0.65	2.76	2.87	3.06	4.58	9.66	1.75	2.00	2.49	2.87	3.06
0.70	2.97	3.09	3.30	4.93	10.40	1.88	2.15	2.69	3.09	3.30
0.75	3.18	3.31	3.53	5.28	11.14	2.02	2.30	2.88	3.31	3.53
0.80	3.39	3.53	3.77	5.63	11.89	2.15	2.46	3.07	3.53	3.77
0.85	3.60	3.75	4.00	5.98	12.63	2.29	2.61	3.26	3.75	4.00
Hrs	4.24	4.64	4.71	7.04	14.06	2.69	3.07			

New Link in Famous Old Mountain Highway Now Paved

Some Construction Features of a California Road Job That Presented Unusual Difficulties

By SAM S. PORTER

Chairman, Good Roads Committee, Chamber of Commerce, San Diego, Cal.

In the bleak region between the Colorado River and the Pacific Coast a modern highway of concrete has been cut through the mountains and deserts which in the days of the gold rush took heavy toll in hardship and death of the hardy pioneers who sought to traverse the then little known country.

The new section reaches from the summit of the divide which separates the drainage basins of the Pacific Ocean and the Colorado River to the foot of the east slope by way of the Mountain Springs Grade. The highway takes its name, Mountain Springs Road, from the old relay station which in early days furnished fresh horses and brief rest for stage coach travelers, but today serves gasoline and supplies to the motorists who speed by on their way to the Pacific.

The original road was cut in the rocks that cover the area through the cooperative efforts of San Diego and Imperial Counties. From time to time, after it became a part of the state highway system, money was allotted to improve the tortuous trail and to widen it. Maintenance of the unpaved surface was heavy and as soon as the final alignment was made and money available, the California State Highway Commission scheduled the section for additional betterment and paving. A 20-ft. cement concrete pavement was selected for the improvement and contract was awarded in August, 1926, to the firm of Jahn & Bressi, Los Angeles contractors.

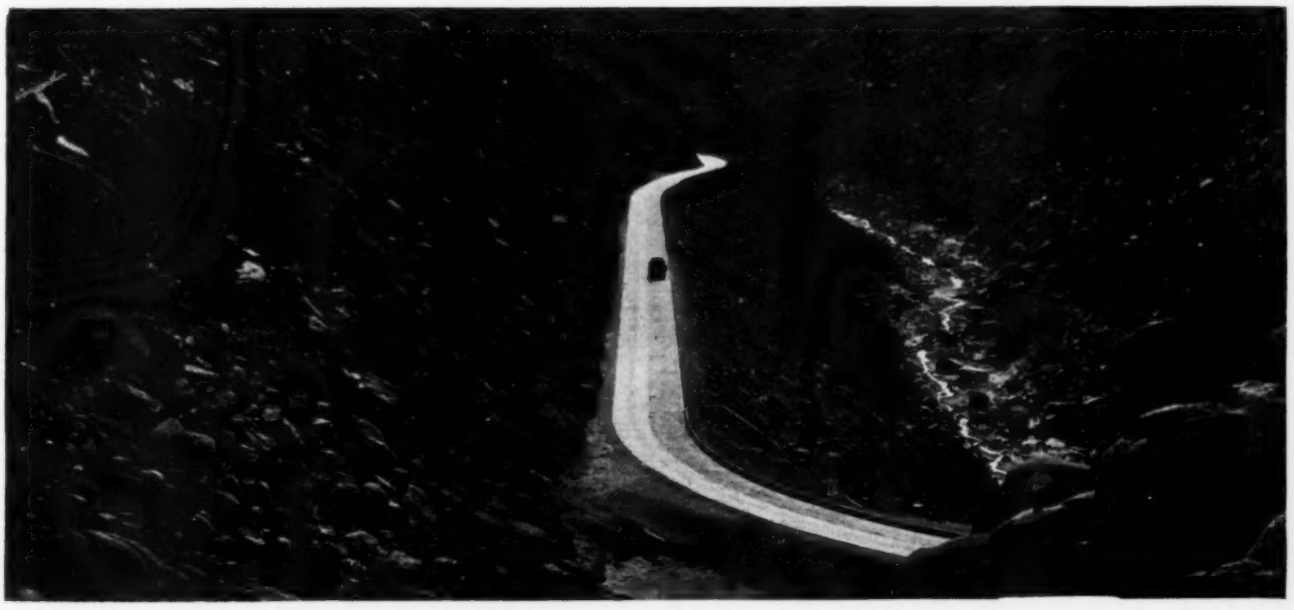
Grading Unusually Difficult.—The Mountain Springs Grade road is a revelation in location and alignment, easy curves and grades, safety features of superelevation and curb provision on the canyon side.

Grading for the pavement on the Mountain Springs Grade presented some unusual difficulties. Due to the character of the ground, largely rock, surfacing dirt had to be hauled in and spread over the grade to provide an even, uniform sub-base. With superelevations and reduction of grades, lengthening curve radii and increasing sight distances, a tremendous amount of earth and rock were moved. In many cases the rock was blasted several times before the pieces were small enough to be handled by a gasoline shovel.

Material and Water Supply.—In preparation for paving, a proportioning plant, the bins having a capacity of 225 tons of material, cement storage sheds and a field laboratory were set up at a railroad siding called Sugar Loaf near the east end of the job. Sand and gravel were shipped in from a point in the Imperial Valley 100 miles distant. Water came from the other end. A pipe line was laid from Jacumba to the scene of construction, approximately 15 miles in all. This line is unique in that it was 82,000 ft. in length, welded 4 in. and 5 in. pipe. It was laid in 20 days.

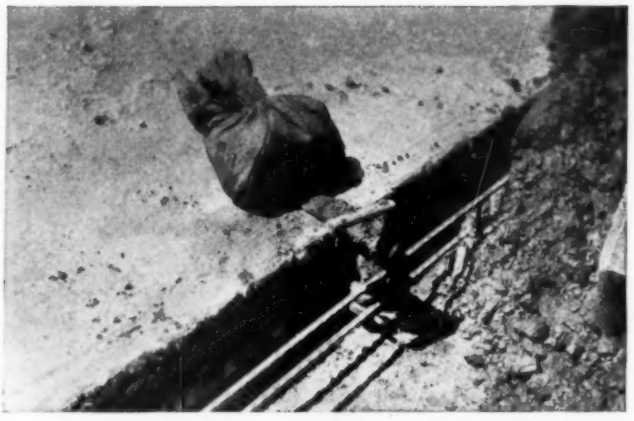
Under state highway specifications, the proportion of materials per batch depends upon the grading of the materials. The requirement is 6 bags of cement per cubic yard of concrete. In the field laboratory the materials are tested and the proportions fixed, while additional tests guard the requirements for cleanness, soundness and general suitability for concrete. Through careful analyses of materials, control of grading and water, finishing and curing, the pavements are uniformly high in strength, durability, riding smoothness and appearance. Cracking of slabs has been eliminated by jointing the pavement into smaller areas. Unique doweling devices and "dummy joints" preserve the riding smoothness at these points.

Pavement Construction.—Actual concreting on this road was started Feb. 2, 1927. The 20 ft. pavement was laid in two 10 ft. strips to facilitate traffic movement as no detour was available, this being the only road across the mountain. Large trucks hauled the



View of Completed Road, Showing the Barren Region Through Which It Was Built

Operating Longitudinal Float from Bridge Resting on the Finished Slab and Outside Form



Close-up of Removable Device for Holding Marginal Bars

proportioned batches of cement, sand and gravel up the grade to the mixer which traveled on the grade. An average of 200 cu. yd. of concrete and better was maintained for every working day. This approximated 1,000 ft. of pavement.

After the concrete came from the mixer it was spread and tamped by a mechanical tamper, followed by hand tamping where the grade exceeded 5 per cent, as much of it does. Final finishing was made through the standard methods of longitudinal floating.

The pavement is all a 9-6-9 in. section with the exception of about 600 ft. of 9-7-9 in. on fills. Each 10 ft. strip of the 20 ft. pavement is thickned at the edges. Two marginal bars reinforce the edges. The bars are placed 3 in. from the top and 3 in. from the bottom of the slab.

Metal Bulkhead for Holding Premolded Expansion Material Until Concrete Was Placed. It Was Slotted to Permit Installation of Dowel Bars

Device for Holding Bars.—A unique device developed by the resident engineer on the work for holding these bars in place consisted of a removable support resting on the side or in the case of the inside of the second strip, upon the edge of the first strip of concrete. Two arms from a vertical shaft hold the bars in the proper place until the concrete is deposited. Then upon a turn of the handle with which the shaft is equipped, the whole device may be lifted out. It is understood that patent has been applied for on this device.

Immediately after the pavement was floated in the final finish, it was covered with strips of wet burlap. These strips were continually soaked with water and remained on the pavement until the surface was covered with wet dirt for final cure. Curing is an important phase in the construction of California's high strength pavement.

Curve Superelevation.—On this road the curves are superelevated as much as 2½ ft. in places where above average speeds are anticipated. Furthermore, the down grade strip is superelevated more than the up grade strip to allow for the speedier travel down hill. Curves have an average radius of 400 ft., unusually sweeping for a mountain road. The sharpest curve of all has a radius of 150 ft.

From the contractor's standpoint, this paving job was a test of organization and equipment. A long initial haul of materials, a steady up grade haul of proportioned batches, heat, wind and inaccessibility to the job by any way other than the road being paved, all contributed to make life one joyous round of taking each step with utmost care.

The approximate cost of the pavement work on the Mountain Springs Grade was $380,000, including grading and repairing damage to grade caused by storm. The highway was completed and opened to traffic during July after a monster celebration staged at Jacumba. The section links two cement concrete stretches on either end and leaves only about 35 miles of unpaved road remaining between San Diego and El Centro.

This highway was built under the supervision of S. V. Cartelyou, District Engineer Division VII of the California Highway Commission, with W. D. Eaton, Resident Engineer, and W. T. Lamb, Assistant Resident Engineer, in direct charge.

Highway Engineering Bureau Organized

The organization of the Highway Engineering Bureau composed of eleven well known engineers has been announced. The bureau will function as a consulting and advisory organization for every phase of the highway, transportation and associated industries. The offices are in the National Press Bureau Bldg., Washington, D. C.

Charles M. Upham, managing director of the American Road Builders' Association, has been elected president of the organization, and Fred E. Schnepfe has been elected vice-president. The advisory engineers of the bureau are Albert T. Goldbeck, Prevost Hubbard, Maurice Holland, Fred A. Reimer, Henry G. Shirley, Earl Stafford, Wm. A. Van Duzer, Dr. J. A. Waddell and Shortridge Hardesty.

The bureau announces that it is now prepared to function in all of the following branches:

Planning highway programs.
Highway finance.
Location, design and construction of highways and pavements.
Contracts and specifications.
Estimates.
Bridges.
Reports on proposed toll bridges.
Materials, selection and economic use.
Research and development.
Organization and administration.
Highway patent service.
Investigations.
City planning.
Grade crossing elimination.
Highway transport and traffic control.
Valuation.
Expert testimony.
Industrial organization and operation.
Arbitration.
Construction efficiency studies.
Service and efficiency tests.
Parks and playgrounds.
Air port locations and development.
Service to contractors.
Foreign representation.

Stone Bases for Asphalt Wearing Courses

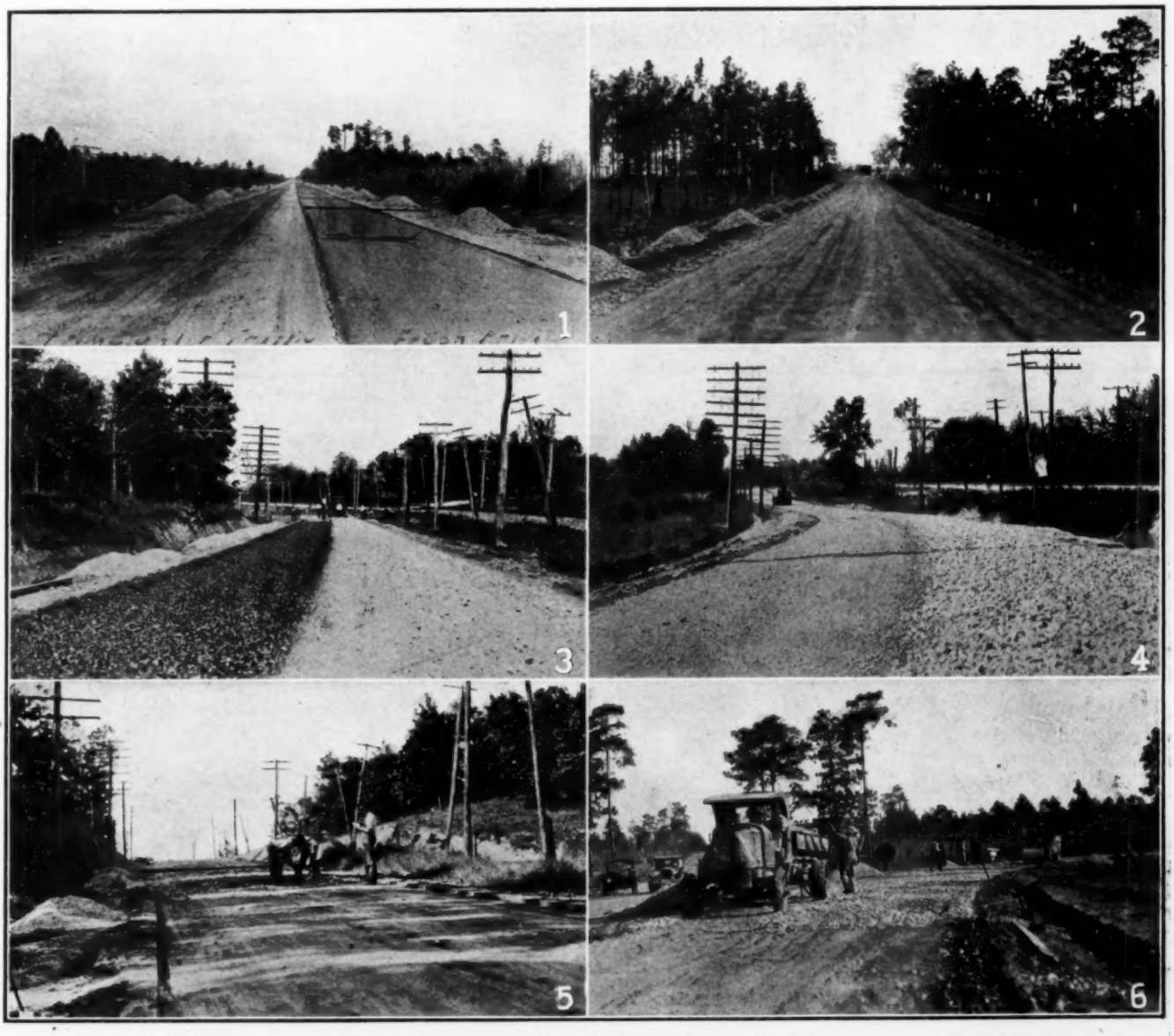
Experiences in Georgia Given in Paper Presented Dec. 1 at 6th Annual Asphalt Paving Conference

By E. N. SEYMOUR

Engineer in Charge of Asphalt Work, Georgia State Highway Commission

On the Georgia highway system, we have completed 256.29 miles of various types of asphalt surfacing on gravel base and 214.08 miles on stone and slag base and have projects under construction totaling 64.61 miles on gravel base and 7.11 miles on stone and slag base. Under our specifications we allow the use of slag where stone is specified so that no distinction is made in the base constructed of these materials, therefore the total mileage is shown as one type.

Types of Surfacing.—On the gravel base the types of surfacing including completed projects and those under construction consist of 201.97 miles of surface treatment from 1 in. to 2 in. in thickness 58.08 miles of 3 in. bituminous macadam 14.38 miles of 3 in. bituminous macadam with 1 in. sheet asphalt seal, 39.38 miles of sheet asphalt with binder, 4.09 miles of 3 in. bituminous macadam with 1 in. rock asphalt seal, 0.50 miles of rock asphalt and 2.50 miles of Topeka mix. On the stone and slag base the types of surfacing consist of 73.10 miles of surface treatment from 1 in. to 2 in. in thickness, 129.17 miles of 3 in. bituminous macadam. 7.21 miles of 3 in. bituminous macadam with 1 in. sheet seal, 11.38 miles of rock asphalt and 0.33 miles sheet asphalt with binder. In addition we have completed and under construction a total of 77.39 miles of asphalt surfacing on limerock base which does not properly enter into this



(1) Two Stages in Application of Tar Prime Coat on Limestone Base; Light Surface Treatment to Follow. (2) Making Ready for Surface Treatment on Gravel Base Which Has Been Compacted by Traffic. (3) One Half of Road With Asphalt Penetration Applied Ready for Stone Chips and Roller. (4) Rolling Stone Before Penetrating with Asphalt. (5) Placing Stone on Gravel Base Which Has Been Compacted by Traffic Preparatory to Penetrating with Asphalt. (6) Surface Treatment on Gravel Base

(1) Completed Sheet Asphalt on Compacted Gravel Base, West of Athens, Ga. (2) Gravel Base Open to Traffic for Compaction on Dixie Highway Between Atlanta and Marietta, Ga. (3) Chert Base in Bartow County Being Used as Surfacing Until Funds Are Available for Top Course.

(4) Gravel Base in Clinch Built as First Step in Stage Construction. (5) Light Surface Treatment on Limerock Base in Wayne County, Georgia. (6) Medium Type Surface Treatment on Chert Base in Murray County, Georgia. (7) Surface Treatment on Gravel Base in Lowndes County. Base Carried Traffic for Two Years

discussion but is mentioned as it is a similar construction.

Under the mileage of gravel base we have included both local and imported clay-gravel, artificially mixed clay gravel, chert and pebble soil. The selection of the type of base has been governed by the location of the project with respect to the source of supply of the base material, the idea being to take advantage of the smaller cost of local materials where possible. As a result we have each type almost exclusively in the particular area where it can be secured locally or where freight rates are favorable.

Chert Bases.—In the northeast corner of the State there are deposits of chert within hauling distance of the state highways. This material consists of about 25 per cent to 35 per cent binder passing the 10-mesh screen and 65 per cent to 75 per cent hard rock retained on the 10-mesh screen. In the natural state there is a large percentage of material too large to be used in the base so it is all run through a crusher and all material crushed to pass a 1¼ in. screen. This material is crushed at the pit. There is one commercial quarry and one owned by the state which crush the material for shipment but the supply is limited and is consumed by nearby projects so that the chert base has not been constructed outside of the area composed of about fifteen counties in the northeast corner of the state.

Our present practice is to construct the base immediately after the grading is completed, for a width of 19 ft. with a compacted thickness of 8 in. although some has been placed in the past with a thickness of only 6 in. It is our intention on these projects, which have not been surfaced with asphalt to increase the thickness of the base of 8 in. before the surfacing is placed.

The chert base acts as a wearing surface during the period required for settlement of the embankment or in case funds are not available for a completed pavement it is used until additional funds become available. Before any asphalt surfacing is placed the base is reshaped and additional material added to give the full 8-in. compacted depth. This method of stage construction gives us a surfaced road immediately after completion of the grading and also insures a completed pavement with true grade and cross-section due to the reshaping after settlement. The cost of this type of base varies from about $0.45 to $0.90 per square yard, depending on the distance the material has to be hauled.

Stone Bases.—In the north central and northeastern sections of the state, there are numerous deposits of stone which are available locally for base courses. The deposits consist of limestone, granite, marble, dolomite and trap rock.

The material is required to show a French Coefficient of wear of not less than six and is graded in size from ¾ in. to 2½ in. Every effort is made to use local stone as well as other local materials for the base course, but the same specifications are adhered to as on imported materials and the local material is rejected if it is not of such **quality as to insure** satisfactory results. This local stone can be secured within hauling distance of many projects. In this section and in these cases the crusher is located at a central point on the project and the material hauled directly from the crusher to the road. There are also commercial quarries which supply the material where a local supply is not available.

Both waterbound macadam and sand clay bound macadam are constructed but owing to the difficulty and expense of securing a sufficient water supply and the further fact that some of the stone is too hard to be bound in this way, practically all of the stone base is sand clay bound. The stone is placed on the road in a uniform layer in such a thickness as to secure the proper compacted thickness, then a sufficient amount of sand clay, not in excess of 30 per cent, to practically fill the voids is placed on top. This is then mixed into the stone by harrowing and rolled until it will not compact further.

This type of base is usually constructed 19 ft. wide with the compacted depth varying from 6 in. to 8 in., depending on the class of material in the subgrade and the thickness is determined in each case by careful study. With this base it is necessary that the asphalt wearing surface be placed as soon as the base is completed as the macadam does not make a satisfactory wearing surface and if traffic is allowed to use it for any length of time it will become so rough and irregular that it will be necessary to practically rebuild it before the surfacing can be placed.

The stone base is generally used in the north central and northeastern sections of the state and down as far into the central section as the price for material and freight rates permit. The cost varies from $0.90 to $1.10 per square yard which is in excess of the cost of the chert base previously discussed and also slightly higher than other gravel types to be mentioned later but the construction is justified for the reason that any other type would cost more in the particular section where stone is used.

In the central section of the state we have occasional deposits of stone and gravel which can be secured within hauling distance also there is a commercial stone quarry and a commercial gravel pit. In addition the freight rate on slag as well as gravel from distant points, is favorable. For these reasons all types of base are constructed in this section, the selection for each project being based on existing conditions for that particular locality. In some cases the conditions governing the cost of the different materials have been so nearly equal that more than one type has been used on one project. This giving us an opportunity to study the relative value of the different types. The construction of the slag base is the same as for the stone as stated in the beginning and this has been described above. The construction of the gravel base will be described later.

"Pebble Soil" Bases.—In the southern part of the state we have deposits of what we term local pebble soil. The average analysis of this material shows about 35 per cent to 40 per cent of metal retained on a 10-mesh screen with a binder composed of well graded sand with clay in the proper proportion. The metal will all pass a 1-in. screen. This material has been used as it occurs locally and with the addition of washed gravel to increase the metal content where this runs low. It has given satisfactory results but can be used only where it is found within hauling distance as the deposits are usually shallow and over comparatively small areas and the cost of hauling for shipping would be prohibitive. In addition there are some deposits of clay gravel but these also are small and can be used only when the road is within hauling distance. By the term "Hauling Distance" which has been used frequently above we mean the distance to which the material can be hauled with economy as compared to the cost of other materials delivered on the work.

Clay Gravel Bases.—With the exception of this limited supply of local material, practically all of the base construction for the southern section has been of clay gravel shipped from outside sources. This is due principally to two reasons, one being favorable freight rates and the other the fact that during the early stages of the road building in this state, a great many miles of gravel roads were constructed and the original investment on these roads is saved in part by utilizing all the gravel remaining and adding a sufficient amount to secure the required thickness of base. In some cases where traffic had been comparatively light it was found that sufficient gravel remained and the asphalt surfacing was applied after reshaping without the addition of any material. The reshaping is usually accomplished by scarifying then smoothing with heavy road graders and compaction secured by traffic with almost constant machining. Where the irregularities are comparatively small, it is not always necessary to scarify but the proper surface can be secured with a heavy road grader provided the gravel has sufficient moisture. Where additional material is placed it is necessary to scarify so that the old and new material is bonded together. In any case it is very important that all loose material be thoroughly compacted under traffic before the asphalt surfacing is added.

In constructing new gravel bases we

use pit run clay gravel and artificially mixed gravel. The latter consists of washed gravel, which has to be shipped, mixed with local clay, sand clay or pebble soil. The mixing process requires great care to get a uniform mixture but this method has the advantage that local materials can be used in part and freight saved.

It has been found most satisfactory to mix the material in two layers as a more thorough mix can be secured. Samples are taken at frequent intervals after the mixing process has been completed and any places which do not show uniformity are remixed, material of either kind being added where necessary. Where suitable local material for binder can be had this type is usually more economical. Both types are required to pass the same specifications which require that all material pass a 1½ in. screen and at least 40 per cent be retained on a ¼-in. screen. The material below this size must be well graded with sufficient amount of clay for binder.

As in the case of reshaping the old gravel it is very important that the gravel be thoroughly compacted for the entire depth and this is done by traffic with constant machining.

The clay gravel has the same advantages enumerated above for the chert base in that it can be utilized as a wearing surface until a more permanent surfacing can be placed and can also be placed immediately after the roadway is graded and can be reshaped later after the embankment has settled and before the more permanent surfacing is added.

The gravel base is constructed to a compacted depth of from 6 in. to 8 in. depending on the sub-grade material and the cost varies from 70 cts. to $1.00 per square yard.

Owing to the fact that the different types have as a rule been constructed in different sections where sub-grade and weather conditions are different and also to the fact that various types of asphalt surfacing have been used it is not possible at this time to draw any conclusions as to relative merit but we consider that the results have been satisfactory with all types when all factors are taken into consideration.

A very close check on the construction methods of the various base courses is being kept as well as of study of the results obtained under different conditions in connection with each type of asphalt surfacing and it is fully expected that definite conclusions can later be made from the observations and results.

6-Mile Ohio Road Job Requires 300,000 Cu. Yd. Excavation.—Route No. 7, Ohio River Road between Shadyside and Dillies Bottom, which may be put under construction next year requires over 300,000 cu. yd. of excavation, most of which is rock, for the 6-mile section.

Effect of Method of Loading in Transverse Tests of Concrete

The growing popularity among highway engineers of transverse tests of concrete has directed considerable attention to this subject. Ease and simplicity of operation, cheapness and mobility of the apparatus have been the main factors which have made the cantilever beam test favored by highway engineers as a measure of the quality of pavement concrete. Concrete Highways in its December issue points out that the results obtained by this method may not always be comparable unless a standard procedure is followed. A number of problems have arisen in conection with methods of making transverse tests and several organizations are working on this question in an attempt to standardize the procedure.

Recent tests in the Research Laboratory of the Portland Cement Association on plain concrete beams using center or ⅓-point loading on a 36-in. span and cantilever loading with a 30-in. overhang, indicate that the modulus of rupture is not the same for the three methods of loading. In general, the size of beam used in the tests was 7 by 10 by 38 in., although other sizes were also used; varitions in the cross-sectional dimensions of the beams affected the modulus of rupture only slightly except for cantilever loading.

In the cantilever tests a special loading apparatus was used which permitted varying the distance between the reactions forming the support and the length of overhang. In all three methods of loading spherical or roller bearings were used to prevent restraint at either the supports or points of application of load. The beams were tested in a 50,000 lb. screw power machine. The travel of the moving head of the testing machine was about 0.05 in. per minute with the machine running idle.

It was found that for the same size of beam (7 by 10 by 38 in.), the moduli of rupture for cantilever loading were, in general, slightly lower than for center loading, while for ⅓-point loading they were about 70 lb. per square inch lower than the average for the other two methods at 3, 7 and 28 days and 140 lb. per square inch at 3 months and 1 year. (See Fig. 1.) In all of these tests the 5 specimens in a set were made on different days from identical mixtures cured in the same manner and tested at the same age.

In the cantilever test the ratio of depth of beam to overhang is important. It was found that shortening the overhang increased the modulus of rupture. It is necessary, therefore, that the cantilever test be standardized if comparable results are to be obtained.

Even though the transverse test becomes generally adopted for field control, it will still be desirable to make occasional check tests on compression specimens in order to correlate the results with the experience of the past which is largely recorded in terms of compressive strength.

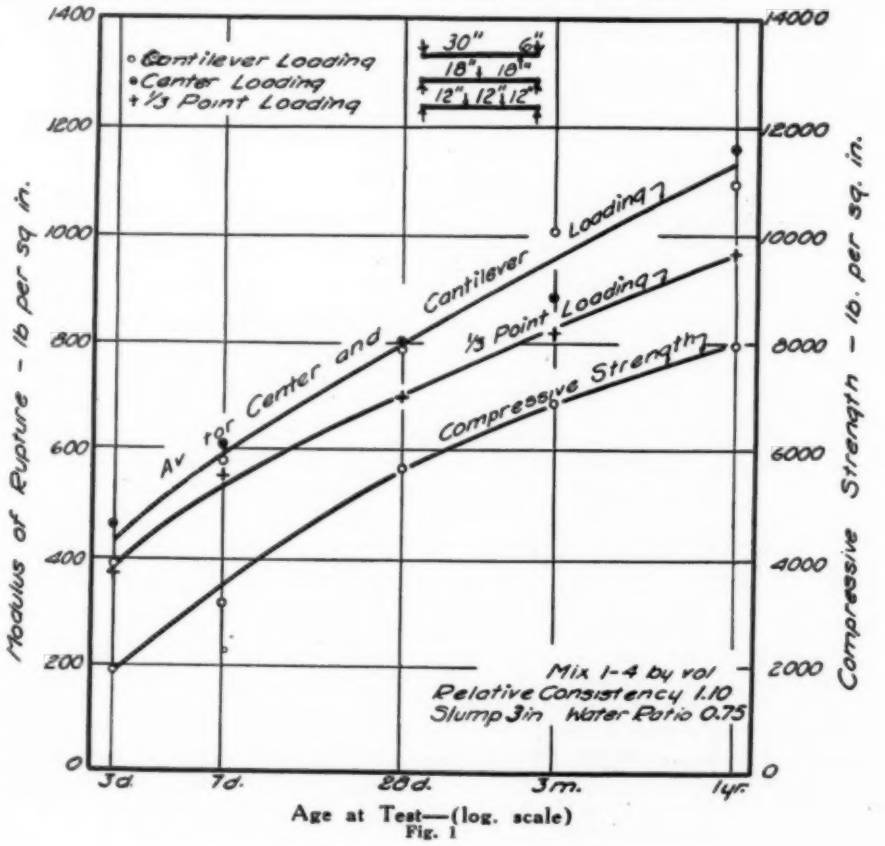


Fig. 1

Cleveland Road Convention and Show

Information Regarding the Annual Meeting of the American Road Builders' Association and Exhibits of Machinery, Methods and Materials for the Construction and Maintenance of Highways

The 25th annual convention and road show of the American Road Builders' Association, which opens Jan. 9th at Cleveland, O., is expected to bring together the largest number of road builders that ever have assembled at a convention of the association. In fact the preliminary exhibition plans indicate that the convention and road show will be nearly twice the size of any previous meeting of the kind. The road show itself will cover more than 150,000 sq. ft. of floor space and will have machinery, equipment and materials of a value in excess of $5,000,000.

The sessions of the convention will be held in the Hollenden Hotel, which is one block from the Auditorium, where the road show will be housed.

The Convention.—The convention will be marked by four significant days. Monday, Jan. 9th, will be manufacturers' day and will give ample opportunity for the manufacturers to present their newly-developed products to the visiting members of their own organization from different parts of the United States, as well as their visiting distributors who are depended upon to carry the new developments of the manufacturers into their local fields.

Tuesday, Jan. 10th, will be Governor's Day. Governor A. V. Donahey of Ohio will be Honorary Chairman of the day.

Wednesday, Jan. 11th, will be Pan-American Day and the program is given over to the special problems important in all countries, as well as the development of closer relations with the Pan-American countries, especially in regard to their highway programs. Dr. E. Gil Borges, Assistant Director of the Pan-American Union, is Chairman of the Pan-American Day and his close identification with the Pan-American countries assures the greatest success for this day.

Thursday, Jan. 12th, is County Highway Officials' Day. The newly-organized division, under its President, Thomas J. Wasser, will have charge of the program for this day. The county division is functioning through eight standard committees, covering the county highway problems. Papers and reports of these committees will constitute the program of this day and all activities will be carried on by county officials. The County Highway Officials' Division is growing fast and gaining a large membership. Several hundred contact men have already been appointed and will act as delegates to the convention.

Friday, Jan. 13th, will be given over entirely to the road show, so that engineers, officials and contractors who have devoted their time to listening to the papers at the convention will have an opportunity to visit the road show and inspect and compare the latest developments in equipment and materials.

The Program of the Convention.—The program of the convention will be coordinated by H. K. Bishop of the Bureau of Public Roads. He will be assisted by Frank Sheets and Fred White in the engineers' sessions and S. M. Williams and Gen. R. C. Marshall in the contractors' sessions. President T. J. Wasser of the County Highway Officials' Division, assisted by Vice-President of the Division, Chas E. Grubb, will have charge of the program on County Highway Officials' Day.

An unusually interesting program of papers has been prepared as will be seen from the advance announcement which follows:

Convention Program

GENERAL SESSION—GOVERNOR'S DAY

Tuesday Morning at 10:00

Grand Ballroom, Hollenden Hotel

Presiding—Mr. Chas. M. Babcock, President, American Road Builders' Association, State Commissioner of Highways of Minnesota.

Address of Welcome by the Honorable John D. Marshall, Mayor of Cleveland.

Response by Mr. Chas. M. Babcock, President, American Road Builders' Association.

Address by Mr. James H. MacDonald, Treasurer, American Road Builders' Association and Honorary Chairman, 25th Annual Convention.

Presentation of emblem to President of American Road Builders' Association.

Presentation of emblems to Past Presidents of American Road Builders' Association.

Address by Rev. Charles S. Macfarland, General Secretary, Federal Council of Churches of Christ in America.

Report on Highway Safety Campaign by Mr. Charles M. Upham, Business Director, American Road Builders' Association.

Address on Highway Safety by Mr. A. H. Brown, Editor and Manager, Motor Touring and Camping.

Tuesday, January 10, 1928

CONSTRUCTORS' SESSION

Tuesday Afternoon, 2:30

Assembly Hall, Hollenden Hotel

Presiding—General R. C. Marshall, Jr., General Manager, The Associated General Contractors of America, Washington, D. C.

"False Credit in the Highway Industry," Alan Jay Parrish, President, Illinois Association of Highway and Municipal Contractors, Paris, Ill.

"Bonding Practices That Should Be Abolished." A. R. Hirst, Chief Engineer, American Vibrolithic Corporation, Washington, D. C.

"What Does Over-Expansion Mean to the Road Building Industry?" Edmund J. Donegan, General Counsel, Metropolitan Casualty Insurance Co. of New York, New York City.

"Demonstration of Responsibility a Prerequisite for Securing a Highway Contract." George F. Schlesinger, Director, Department of Highways and Public Works of Ohio, Columbus, Ohio.

ENGINEERS' SESSION

Tuesday Afternoon, 2:30

Grand Ballroom, Hollenden Hotel

Presiding—Mr. Fred R. White, Chief Engineer, Iowa State Highway Commission, Ames, Iowa.

"Demonstration of Responsibility a Prerequisite for Securing a Highway Contract." W. R. Creighton, Foster & Creighton, Nashville, Tenn.

"Footprints of the Engineer." J. B. Weaver, Attorney, Des Moines, Iowa.

"Measuring Materials for Concrete." R. G. Giles, Chief Engineer of Concrete Control, Blaw-Knox Co., Pittsburgh, Pa.

Wednesday, January 11, 1928

PAN-AMERICAN SESSION

Wednesday Morning, 10:00

Grand Ballroom, Hollenden Hotel

Presiding—Dr. E. Gil Borges, Assistant Director, Pan-American Union, Washington, D. C.

Co-Chairman, A. Madrazo, Comision Nacional de Caminos, Mexico, D. F.

"Cuba and Her Highways." Armando Valdes, Compania Cubana de Contratistas.

"Roads Built in Mexico." Julio Garcia, Engineer, Comision Nacional de Caminos.

"Highway Work in Alaska." M. D. Williams, United States Bureau of Public Roads.

"Road Work in Panama." Delegate to be appointed.

"Road Work in Colombia." Julio Fajardo, Engineer.

"Central Highway of Cuba." M. A. Corroalles, Construction Engineer, Cuban Department of Public Works.

Wednesday, January 11, 1928

ENGINEERS' SESSION

Wednesday Afternoon, 2:30

Grand Ballroom, Hollenden Hotel

Presiding—Mr. Frank T. Sheets, Chief Highway Engineer of Illinois, Springfield, Ill.

"Snow Removal." V. R. Burton, Engineer of Research and Statistics, Michigan State Highway Department, Lansing, Mich.

"Automobile Accidents at Railroad Grade Crossings." Homer D. Howard, Locomotive Engineer of the "Panama Limited," Illinois Central Railroad.

"Traffic Irritants." Sidney J. Williams, Director, Public Safety Division, National Safety Council, Chicago, Ill.

CONSTRUCTORS' SESSION

Wednesday Afternoon, 2:30

Assembly Hall, Hollenden Hotel

Presiding—Mr. S. M. Williams, Manager, The Autocar Sales & Service Co., Chicago, Ill.

"Depreciation of Road Builders' Equipment." William R. Smith, President, The Lane Construction Corp., Meriden, Conn.

"What Can Organization Do for the Contractor?" A. H. Hunter, Engineer, Illinois Assn. of Highway & Municipal Contractors.

"The Pernicious Triplets of Construction." H. R. Wilson, Managing Partner of Winston Bros. Co., and H. H. Wilson, Vice-President, The Associated General Contractors of America, Inc.

Wednesday Evening, 7:30

Hollenden Hotel

ROAD BUILDERS' ANNUAL BANQUET

Thursday, January 12, 1928

COUNTY HIGHWAY OFFICIALS' DAY

Thursday Morning, 10:00

Grand Ballroom, Hollenden Hotel

Presiding—Mr. Thomas J. Wasser, Supervising Engineer, Board of Chosen Freeholders of Hudson County, Jersey City, N. J., and President, County Highway Officials' Division of the American Road Builders' Association.

Report of Committee on Surveys and Planning. Chairman, Stanley Abel, Supervisor, 4th District, Kern County, Taft, Cal.

Report of Committee on County Highway Construction. Chairman, Chas. E. Grubb, County Engineer, Newcastle County, Wilmington, Del.

Report of Committee on Rural County Highway Maintenance. Chairman, F. B. Wilkes, Supt. of Roads, Maury County, Columbia, Tenn.

Report of Committee on Urban County Highway Maintenance. Chairman, W. W. Chadsey, County Supt. of Highways, Schenectady County, Schenectady, N. Y.

"Improved Service on County Roads by Low Cost Methods." C. N. Conner, Chairman, Low Cost Improved Road Investigation, Highway Research Board, National Research Council, Washington, D. C.

Thursday, 12:30 P. M.

Meeting, Board of Directors, County Highway Official Division, American Road Builders' Association.

Thursday Afternoon, 2:30

Grand Ballroom, Hollenden Hotel

Presiding—Mr. Chas. E. Grubb, County Engineer, Newcastle County, Wilmington, Del., and Vice-President, County Highway Officials' Division of the American Road Builders' Association.

Report of Committee on County Highway Legislation. Chairman, H. B. Keasbey, County Engineer, Salem County, Salem, N. J.

Report of Committee on County Administration. Chairman, R. B. Preston, Engineer, County Commission of Roads and Bridges, Norfolk County, Portsmouth, Va.

Report of Committee on County Road Construction and Maintenance Equipment. Chairman, E. L. Gates, Superintendent of Highways, Du Page County, Wheaton, Ill.

Report of Committee on County Highway Finance. Chairman, John J. McHugh, Deputy Clerk, Board of Chosen Freeholders of Hudson County, Jersey City, N. J.

Thursday Afternoon, 5:00

Assembly Room, Hollenden Hotel

Business Meeting, County Highway Officials' Division, American Road Builders' Association.

Friday, January 13, 1928

12:30 P. M.—Meeting, Board of Directors, American Road Builders' Association.

Friday Afternoon, 4:30

Assembly Room, Hollenden Hotel

Business Meeting, American Road Builders' Association.

The Road Show.—Over 300 equipment and material producers will exhibit for inspection their latest developments. Many of the exhibits will be in operation. Many new pieces of equipment and improvements in materials will be exhibited. Brief descriptions of some of these appear elsewhere in this issue. A list of all exhibitors who on Dec. 19th, had completed contracts for space, together with their booth numbers and a brief outline of the nature of their exhibit when these were obtainable follow:

The Exhibitors at the 1928 Road Show

AC Spark Plug Co.—Booth E H-6. AC Spark Plugs, AC Air Cleaners, AC Oil Filters. Prosper Champion in attendance.

Acme Motor Truck Co.

Acme Road Machinery Co.—Motion picture of equipment. Literature will be distributed. H. A. Schaupp, Secretary and Assistant Manager in charge.

J. D. Adams & Co.—Booth W W-4. Adams adjustable leaning wheel graders, road maintainer, Elevating grader, dump wagon, and a new Motor Grader. E. E. Christen in charge assisted by sales representatives.

AGA Company.—Booth A A-55. AGA flashing beacons. Electric stop and go signals. Reflector signs and signals. G. G. Kelcey, E. N. Johnson and T. E. Orr in attendance.

The Alloy Cast Steel Co.—Booth E S-36. Steel castings. Regular steel for strength and durability. Alloy steels for severe and special duty.

American Bosch Magneto Corp.

American Casting Co.

American Cement Machinery Co.—Booth E H-43. Boss 10-S. One-Two Bagger, Concrete Mixer. C. J. Kirch and B. J. Kirch in attendance.

American City.—Booth A A-45. Magazine.

American Gas Accumulator Co.

American Hoist & Derrick Co.

American Manganese Steel Co.—Booth A A-21. Missabe Dipper, Amsco Dredge Pump, Amsco Apron Feeder. Various types of Manganese Steel Castings used in road building equipment. A. W. Daniels, J. P. Murtaugh, E. F. Mitchell, J. J. Chaps in attendance.

American Steam Pump Co. of America

American Steel & Wire Co.—Booth A A-5. Concrete reinforcement, both electric welded and triangle mesh for use in highways, roadways and pavements, also for sewer pipe and curbing. Also steel fence post for highway and roadway signs. American wire rope for highway guard cable. B. S. Pease, O. T. Allen, J. G. Schodtler, A. T. Merriman, P. T. Coons, B. B. Ayers, W. H. Cordes in attendance.

American Tar Products Co.—Lounge, where customers and friends may assemble. Paul L. Griffiths, manager of the Tarmac Department of the American Tar Products Co., in charge of the booth.

American Vibrolithic Corporation. — Booth H-61. A vibrator and Standard Platform section, together with samples of our pavements and a complete supply of descriptive literature. It is also likely 16-mm. picture films will be projected, one showing the construction of vibrolithic and the other the building of interlocking bituminous pavements. H. L. Tillson, L. R. MacKenzie, President; N. D. Dean, Executive Vice-President; A. R. Hirst, Chief Engineer; P. S. Bookwalter, Licensee; H. W. Dawson, Licensee; J. E. White in attendance.

Ames, Shovel & Tool Co.

Amiesite Asphalt Co. of America

Anthony Co., Inc.

Armco Culvert Assn., Culverts and Fittings

The Asphalt Association.—Exhibit will feature a large wood carving of King Nebuchadnezzar of Babylon dedicating the first roadway paved with asphalt. In addition charts will be shown illustrating gains in the use of asphalt for paving purposes. Sawed sections and photographs of various types of asphalt pavements will also be exhibited and publications and specifications describing these pavements will be available for distribution.

Asphalt Block Pavement Co.

Asphalt Brick Co.—Booth A H-7. Projecting machine showing moving pictures of installations such as bridge floors and repairing of plumber and utility cuts using A-B-C asphalt brick. A Stelzer Trench cover which is used in connection with the new A-B-C method of repairing plumber and utility cuts in pavement. L. V. Fox, General Manager in charge.

Associated Pennsylvania Contractors.—Booth W W-1A. Rest room for visiting constructors. W. D. Maxwell in charge. Exhibit of the Associations Magazine **"Highway Builder"** in charge of Thos. M. Hatch.

Athey Truss Wheel Co. Booth Y-34. 4-5 yard (10-Ton) hydraulic rear dump tractor trailer coupled direct to Caterpillar "Thirty." One-15-Ton Athey Truss Wheel. J. A. Roberts, C. E. Patterson and Roger Barlow in attendance.

The Atlas Lumnite Cement Co.—Booth E H-34. Atlas Lumnite Cement. Photographs of actual construction jobs and literature describing work done with Lumnite will be available at the booth. C. S. McArdle and others in attendance.

Austin Machinery Corp., Chicago. New Trencher

Austin-Western Road Machinery Co.—Booth A A-22. One of the new Austin worm-drive Autocrat rollers, the Athey 7-yd. dump wagon, the Western hot patch road repair outfit, a new 5,000 lb. grader and a new 12 ft. leaning wheel grader, also a regular motor grader in both the round and caterpillar type tread.

Autocar Sales and Service Co.

The Baker Mfg. Co.—Booth W W-17. Baker Maney Self-Loading Scrapers, Baker One-Man Rotary Scrapers, Baker "V" and Blade Snow Plows for Motor Trucks and Tractors. J. G. Miller, Vice President; E. E. Staley, President; W. C. Staley, Vice President and L. A. Ginzel, Secretary in attendance.

Baldwin Tool Works.—Booth A H-17. Shovels, spades and scoops. H. Cunningham, Vice-President in charge.

Banting Manufacturing Co.

Barber Asphalt Co.

Barber-Greene Co.—Booth W W-43. Models, Movies, and actual machines as follows: Ditcher, Bucket Loader, Portable Belt Conveyor. H. H. Barber, H. L. Greene, W. B. Green, E. D. Cassel, J. E. Marson, W. Buell, J. Turner in attendance.

Barnes Mfg. Co.—Booth 56 W W. Triplex road pump, model 35 mounted on springs. Single diaphragm pump Model F302. A lift and force pump Model No. F305 mounted on springs on a two wheel trailer with rubber tires. Double diaphragm outfit on four wheeled truck. Centrifugal pump Model No. 702. Single trench pump No. F306. A high pressure pump Model No. 161 on truck. A double acting force pump Model No. F72 on truck. Duplex plunger trench pump complete on truck with housing and air cleaner. A. C. Saxe, G. N. Ristie and J. C. Gorman in attendance.

The Barrett Co.—Booth A A-17. Tarvia distributors; various illustrations of the use of Tarvia in road construction, repair and maintenance. Executives and salesmen from all parts of territory in attendance.

Bates Mfg. Co.

Bay City Dredge Works.—Booth A Y-32. Central Armory. 1.—Model 16-B ¾ yd. convertible excavator equipped with full crawlers and skimmer bucket. 1.—Bay City Tractor Shovel with I. H. C. Tractor and ⅝ yd. shovel. 1.—Bay City Tractor Trencher with I. H. C. Tractor and Trench Scoop. New Model. Morgan Ramsay, sales manager; Eugene Reading, Eastern sales manager; W. S. Ramsay President in attendance.

R. H. Beaumont Co.

Black & Decker Mfg. Co.

Blackhawk Manufacturing Co.—Booth N E H-1. Complete line of hydraulic oil power jacks —from 1½ ton to 75 ton capacity—in various different heights to meet practically all automotive and industrial needs. Also exhibit a complete line of socket wrenches—sizes covering all automotive and industrial requirements. H. P. Brumder, J. W. Lovelady, E. M. Pfauser, W. P. Ferris, E. G. Bott, L. A. Gerber in attendance

Blair, W. H., Mfg. Co.

W. M. Blair Mfg. Co.—Booth A Y-29. North Hydraulic Digger, North Hydraulic Crane, North Hydraulic Bulldozer, R. B. North, F. G. Hough, manager in attendance.

Blaw-Knox Co.—Booth A A-18. A 51-ton hinged leg portable bin equipped with double weighing batchers, a combination of the volume and weight method plus auxiliary dial. A 100-ton portable pedestal type assembled bin, completely equipped with the inundation system for road construction. A complete setup of Blaw-Knox improved road forms. Complete setup of Blaw-Knox steel forms for street, curb, and sidewalk construction. The new Blaw-Knox dragline bucket. The improved ball-bearing Blaw-Knox clamshell bucket. A comparison of self-cleaning and non self-cleaning principle in bin design and construction. Blaw-Knox truck turntables. All-steel batch box. Calcium chloride machine. Chester H. Lehman, Edward M. Ornitz, Arthur A. Levison, M. G. Martin, A. S. Wolf, O. A. Olstad, C. R. Hunter, Wm. P. Favorite, B. W. Ranson, J. C. McQuide, H. A. Camlin, Prescott V. Kelly, J. H. Flynn, E. L. Harrington, Gustav Schirmer, R. A. Wholley, Arnold Hooper, J. G. Riley, S. G. Hawkins, H. B. Fuller, A. C. Featherstonhaugh, Robert T. Harris, Wm. E. Balliet, L. L. Cassard, and Frank J. Nugent in attendance.

Robert Bosch Magneto Co.—Booth E H-48. Magnetos, generators, spark plugs, horns, battery ignition systems. "No-Battery generator outfits. Fordson magneto and governor outfits. L. C. Carlton, Carl Belin, Jr. in attendance.

Brookville Locomotive Co.

Browning Crane Co.

Brown-Lipe Gear Co.—Booth W W-70. Model 20-4S. U. P. P. transmission. Model 70-7S. transmission. Model 60-3S. auxiliary transmission. Power take-offs, 15 in. Industrial clutch. Model 51-5S. transmission. A. E. Parsons, General Manager; J. O. Pierce, Sales Manager; E. S. Nottingham, Ass't Sales Manager; Henry A. Pierce, Chicago Sales Representative; E. A. Brown, Ass't Service Manager; R. V. Hessler, Eastern Sales Representative in attendance.

The Buckeye Traction Ditcher Co.—New service ditcher.

Bucyrus Co.

The Buda Co.—Buda Power Units Buda M. A. N. Diesel Engines, Buda-Hubron Earth Drills. R. K. Mangan in attendance.

Buffalo-Springfield Roller Co.—Booth W W-83. Several tandem and three-wheel steam and motor paving rollers, some with pressure scarifiers and one with grading blade. W. H. McClenen, W. J. Hazeltine in attendance.

The Buhl Company.—Booth W W-24. Portable compressors, Combination Compressor and Hoist. C. N. Sutton, W. J. Buhl in attendance.

Bunting Brass & Bronze Co.

The Burch Corporation.—Booth W W-86. Car unloader, portable conveyor, coal unloader, stone spreader, asphalt spreader. C. R. Beaver, J. A. Ecki, E. C. Bishop in attendance.

Butler Bin Co.—Booth W W-42. Full size V-40 cu. yd., two compartment bin equipped with a set of latest type of Butler weighing hoppers. Also a set of type A standard measuring hoppers and a miniature working model of a type V-40 cu. yd. two compartment bin complete with a set of measuring hoppers. Also show moving pictures showing the method of erecting and dismantling the different type of bins and other pictures. Morgan R. Butler, A. R. Morton and Carl E. Riblet in charge.

The Butler Manufacturing Co.—Booth N E H-17. A Butler vacuum street sweeper. S. D. Weil, A. W. Conley, E. R. Smead, J. D. Conley, F. W. Blaisdell in attendance.

Buttenheim-Dix Co.—Booth E H-18. Magazines, Publications.

Byers Machinery Co., The

The Philip Carey Co.—Booth E H-99. Elastite expansion joint; Elastite bridge flooring, (a comparatively new addition to the group of Elastite products), Elastite track insulation, and Elastite preformed track pavement. C. V. R. Fullenwider and H. C. Jussen in charge.

Carter Co., Ralph B.

Caterpillar Tractor Co. "Caterpillar" tractors. M. M. Baker, H. M. Hale, W. H. Gardner in attendance.

Celite Products Co.—Booth E H-11. Workability agent for concrete. H. L. Dunham, Concrete Engineer; C. A. Frankenhoff, Division Sales Manager; E. S. Crosby, Sales Manager in attendance.

Central Alloy Steel Corp.

Chain Belt Co.

Chausse Oil Burner Co.—Booth W W-37. Portable asphalt plant and tar kettles. W. McK. White and M. R. Elliott in attendance.

C. H. & E. Manufacturing Co.—Booth W W-52. Milwaukee, Wis., No. 11 Triplex Pump, No. 12 Centrifugal Pump, No. 28 Saw Rig, No. 23 Double Drum Hoist, Mud-Hen Diaphragm Pump. Wm. Schneller, F. F. Hase in attendance.

Chevrolet Motor Co.—Booths N E H-28 and 30. One ton chassis with four speed transmission. No Cab. One ton truck with Wood-hydraulic body and Wood power take-off. Chevrolet Cab. One ton truck with Anthony gravity dump. Chevrolet Cab. One ton truck with Hercules bottom dump. Chevrolet Cab. One ton truck with Superior Dump body. Chevrolet Cab. E. R. Palmer, zone manager at Cleveland in charge.

Chicago Automatic Conveyor Co.

Chicago Pneumatic Tool Co.—Booth E S-5. Full line of portable air compressors—100 cu. ft. to 310 cu. ft. Also complete line of rock drills paving breakers, clay diggers, tampers, concrete surfacers, chipping hammers, rivet hammers, pneumatic and electric drills. J. C. Fitzpatrick, District Manager of Sales, Cleveland district in charge.

The Cleveland Hardware Co.—Booth N E H-12. Guard rail hardware such as eyebolts, hook bolt, anchor rods, turn buckles, etc., also forgings and stampings rod and yoke ends levers either blank or finished for road machinery tractors etc.

Cleveland Tractor Co.

Cleveland Trencher Co., The

Climax Engineering Co.—Booth A A-57. Complete units ready for dealer to sell and contractor to use. Largest exhibit an 85 h. p. engine especially adapted for sand pump drive, radiator cooled with a Perfex radiator, complete with vacuum feed, service pump drive and electric starter and generator. Another unit is Climax Model "KU," four cylinder, 5 in. by 6½ in., engine connected by flexible coupling to a Dayton-Dowd 6 in. water pump capable of delivering 1,200 gallons per minute against a 75 in. head, also a "TU," 4 cylinder, 5½ in. by 7 in., complete portable power units and a 6 cylinder, 6 in. by 7 in., engines, complete with the equipment as required by the Underwriters' Laboratory for fire standby purposes on 1,000 gal. pumps. Lorimer Dunlevy in charge.

Clyde Iron Works Sales Co.—Booth A A-41. Improved gasoline hoist, welded steel base and hydraulic friction, special advancemnt in hoisting engine design. Jack Frost, General Sales Manager in attendance.

Commercial Shearing & Stamping Co.

Commercial Steel Castings Co., The

Complete Service Publishing Co.—Booth E H-8. Booth only, no display.

Concrete Steel Co.—Exhibiting at this show for first time its electrically welded highway reinforcement, made from ⅝ in. deformed bars; also new installing devices, a new method of center line construction and a new method of reinforcing asphalt pavements. Pre-cast asphalt center joint will be shown and probably a new method of permanent fire-proof building construction.

The Concrete Surfacing Machinery Co.—Booth E H-75. Berg concrete surfacers and finishers, electric and air driven. Berg concrete highway surfacers, air cooled gas engine driven, electric driven. M. Wetstein, S. Dreifus, S. M. Wetstein in attendance.

Conneaut Shovel Co.—Booth A A-57. Hand shovels, spades and scoops. Ditch and drain tools. Telephone shovels and spoons. Robt. Van Gorden in attendance.

Construction Machinery Co.—Booth E H-63. Latest Wonder Mixer with loader and water tank; also concrete hoist with many new features. Paul Johnson, sales manager, in attendance.

Continental Motors Corporation.—Booths E H-93 and 105. Several new engines, as well as complete industrial series from 5 to 96 HP. L. J. Kanitz, Industrial Manager; A. R. Long, S. F. Evelyn, A. R. Smith, A. D. Chandler, S. Nixon, A. M. Sampson and C. R. Wassell in attendance

Cyclone Fence Co.—Booth E H-73. Cyclone Road Guard. "Gaen After" Chain Link Fencing. H. G. Chapman, General Sales Manager; R. E. Pinniger, District Sales Manager in attendance.

Cummer & Son Co., F. D.

Curtis-Pneumatic Machy. Co.

D-A Lubricant Co. Inc.—Booth W W-80. D-A Lubricant. Frank L. Binford, President; Paul L. Lablant, Sales Manager in attendance.

Dayton Steel Foundry Co.

Deister Concentrator Co.

Differential Steel Car Co.—Booth W W-113. The Differential Thre Way Motor Truck Dump Body in action, also moving pictures of trucks in actual operation. H. Fort Flowers, Shelly G. Hughes, Harry T. Thompson, Ralph E. Stuntz, E. M. Blackford in attendance.

Ditwiler Manufacturing Co. Dump Body Hoists

Domestic Engine & Pump Co.—Booth W W-54. One Self-oiling, Hyatt roller bearing equipped "Giant" triplex road pump. One Self-oiling, Hyatt roller bearing equipped double diaphragm pump. One Vertical plunger force dewatering pump. One "Domestic" centrifugal pump. W. E. Barbour, Sales Manager; C. B. Segner, Vice-President in attendance.

Dot Lubrication Division Carr Fasterner Co.—Booth W W-38. Industrial lubrication devices for power shovel, hoists, pumps, pavers, etc. P. K. Niven, A. W. Smith, C. L. Hall, R. D. Dumont, L. H. Hein, J. N. Fauver, Ed. Harkins, G. P. Dempler in attendance.

The Dow Chemical Co.—Booths E H-95, E H-103. Miniature road showing results obtained from the use of Calcium Chloride on gravel roads; moving picture exhibit showing the use of Calcium Chloride in connection with maintenance and dust prevention on gravel roads, and the use of Calcium Chloride as a curing agent in concrete construction work. S. W. Putnam (in charge), D. Williams, Harold Knowles, Wm. MacGillivery, T. E. Williams, George Metcalf in attendance.

Eaton Axle & Spring Co., The

Eberhard Mfg. Co.—Malleable iron castings. Hardware and fittings for road machinery. Arthur L. Wheeler, Vice-President; C. R. Hennicke, C. F. Schleicher, R. H. McGrath, Wm. Bauer, Geo. Thobaber in attendance.

C. D. Edwards Mfg. Co.—Booth N E H-36. New model dual blade motor patrol having new features to take the "corduroy" out of roads, mounted on 10-20 McCormick Deering, (a new addition) and the Edward 12 ft. grader also a new addition. Weight 9,775 lbs. Timken bearings, all enclosed gears, etc., also several other machines from standard line. Roger D. Edwards and many territorial representatives in attendance.

Eisemann Magneto Corporation.—Booth E H-39. Full line of high tension magnetos. T. E. Kennedy, sales manager; B. B. Woodford, assistant sales manager; O. S. Stanley, Chicago district manager, and I. W. Edwards, Detroit district manager, in attendance.

Electric Wheel Co.

The Elgin Corporation.—Booth W W-63. 1928 Elgin motor pick-up sweeper. Geo. C. Dodge, President, The Elgin Corporation; A. M. Anderson, Secy.-Treas., The Elgin Corporation; B. L. Crandall, Adv. Mgr., The Elgin Corporation; J. W. Aspinwall, Marathon, N. Y.; J. H. Sneider, Pittsburgh, Pa.; G. A. Pratt, Boston, Mass.; Geo. W. Fife, Indianapolis, Ind.; W. M. Tyler, New York; W. C. Robertson, New York; C. W. Barnthouse, Toledo, O.; W. I. Thompson, Jackson, Mich.; D. M. Todd, President, Elgin Street Sweeper Co. in attendance.

Equipment Corp. of America

Erie Malleable Iron Co. (Van Metal Wheel Division).—Van single front and dual rear pneumatic wheels—an original and exclusive design using Firestone "B" beadless demountable rims. Wheels are furnished with hubs cast integral. J. W. Vanderveer and B. H. Scott in attendance.

Erie Steam Shovel Co.

Erie Steel Const. Co.—Booth W W-55. 33 ton capacity, 2-compartment steel AggreMeter plant with weighing AggreMeter; one set volume AggreMeters; one 1-yd. Peerless Clam Shell Bucket also models. J. A. Auld, G. H. Strayer, T. R. Buss and E. F. Jones in attendance.

E. D. Etnyre & Co.—Booth W W-84. Oil tar and asphalt heating and distributing unit mounted on standard motor truck chassis. G. M. Etnyre, H. H. Etnyre, R. D. Etnyre and G. E. Pearson in attendance.

The Euclid Crane and Hoist Co.—Booth E S-13. One automatic wheel scraper, one rotary Fresno, one dump trailer. A. P. Armington and S. F. Armington in attendance.

Everhot Manufacturing Co.—Booth E H-27. Everhot branding, equipment, saw horse heads, blow torches, steel stamps, sidewalk stamps, bridge plates, weatherstrip, coal chutes. J. H. Payton in attendance.

Fairbanks, Morse & Co.—Booth W W-28. 60 h. p. Diesel dredge engine for road service, a sectionalized squirrel-cage ball-bearing motor "running on a little air," a sectionalized motor-driven ball-bearing centrifugal pump, a two-stage air compressor, belt-driven by a 1,500 watt power plant, wheel load scales and gasoline engines. T. M. Roble, T. G. Oetzel, K. W. Jones, R. J. Roy, P. T. Anthony, J. R. Patterson, W. P. White, T. Edw. Morrison and Glen H. Corlette in attendance.

Farasey Mfg. Co., The J. D.

Farrell-Cheek Steel F. Co.—Booth W W-36. Castings made of special purpose cast steel —Farrell's 85—which is especially suited to such parts as track shoes, track rollers, sprockets, pinions and gears, sheaves, bucket lips, digger teeth, side cutters, and in fact all parts subject to extreme wear and impact and shocks. E. F. Pickslay, M. L. Ritter, W. C. Scott in attendance.

Fate-Root-Heath Co.—New 12-ton Diesel locomotive.

Federal Motor Truck Co.—Booth W W-75. A 2-ton road builder chassis with dump body and a 3-ton chassis with dump body, each truck to be equipped with either seat or cab. W. H. Miller, E. W. Winans, H. A. Broat, A. C. Harold in attendance.

S. Flory Mfg. Co.—Booth W W-21. 100 h. p. electric double drum; two speed, band friction, slack line excavation hoist; 35 h. p. double drum gasoline hoist; 8 h. p. double drum gasoline hoist. Theo. Hanan and C. L. Nesbitt in attendance.

The Foote Company, Inc.—Booth W W-95 MultiFoote Paver.

Ford Motor Company

Four Wheel Drive Auto Co.—One model-commercial Utility FWD truck, equipped with dump body under body hoist, 6-cylinder motor, electric lighting and starting system, enclosed car, rotary snow plow, pneumatic tires.

French & Co., A. W.

French & Hecht.—Booths E H-45 and 57. Wheels as applied to the road industry and will include wheels to be used on trailers of various types to meet present road construction. Exhibit includes tractor drive wheels with flat spokes, a 50 by 10 dual expansion wheel for industrial tractor placed on a turntable, a Fordson expansion wheel, trailer wheel, road grader wheels, motor truck wheels, etc., etc. W. F. Heesch, General Manager; H. J. Rober, Manager, Springfield Plant; E. F. Myers, Supt., Springfield Plant; E. E. Einfeldt, Engineer; J. H. Ploehn, Superintendent; E. R. Wiggins, Advertising Manager; W. H. Breedlove, Sales Engineer; J. W. O'Connor, Office Manager in attendance.

Fruehauf Trailer Co.—Booth W W-87. One heavy duty drop frame carryall, one dual hopper materials trailer, one flat deck cement trailer, one municipal waste collecting trailer. G. W. Chamberlin, W. B. Chapoton, C. L. Schneider, H. S. Moore and O. F Neuman in attendance.

Fuller & Johnson.—Booth E H-31. A complete line of horizontal and vertical engines. A number of new and special features will be shown as well as one or two new engines. A line of electric power and lighting plants. A. H. Holt and C. G. Cook in attendance.

Fuller & Sons Mfg. Co.—Booth N E H-22. Full line of transmissions and clutches for motor trucks and road machinery made up as cutaway samples, and electrically driven by concealed motors and belts in order to show the operation. John H. Earle, Sales Manager; George W. Fuller, District Sales Manager; Fred R. Dowsett, General Manager, and Lawrence C. Fuller, Vice-President and Chief Engineer, in attendance.

Galion Iron Works & Mfg. Co., The. Road Rollers, Road Graders

The Gardner Governor Company

General Excavator Co., The

General Motors Truck Co.—Booth W W-97. A General Motors Model K-72, 3½ ton capacity truck with a 4-yard Woods hydraulic dump body, 148-in. wheelbase, and also a Model T-50 standard chassis.

General Wheelbarrow Co.—Booth E S-15. Concrete buggy, wheelbarrows, salamander, steel mortar box, Fresno scraper, drag scraper. W. A. Gordon, Geo. M. Lawther, L. P. Colebrook and H. E. Haiman in attendance.

Geneva Metal Wheel Co.—Booth E S-32. Rubber tired and plain steel wheels, "High-Test" roller bearings and steel axles. Hand and steering wheels for road machinery. H. A. Carter and R. C. Patterson in attendance.

Gifford-Wood Co.—Booth A H-19. One street ice leveler, also two frames of photographs showing these machines in actual use. Frames will be illuminated. Also bulletins, catalogs, etc. Mr. Philip Wood, vice-president and secretary, in attendance.

Gillette Publishing Co.—Booth E H-59. Magazines: "Roads and Streets," "Engineering and Contracting," "Water Works," "Municipal News;" technical books.

Ginnetti, Frank

W. S. Godwin Co.—Booth A A-1. Steel guards for protecting edges of paving. W. S. Godwin and J. L. Perkins in attendance.

Good Roads Machy. Co.

Good Roads.—Lounge for guests. Issues of Good Roads. J. H. Burton, F. J. Foley, C. W. Edwards, E. W. Tree and R. M. Klein in attendance.

Goroco Mechanical Spreader Co.

Gotfredson Truck Corp.

Graham Brothers

The Grasselli Chemical Co.—Booth E S-16. "R-B" silicate of soda for curing concrete roads and streets. Zinc chloride for preserving wooden guardposts and rails. R. F. Remler and H. E. Davis, in attendance.

Gruendler Patent Crusher & Pulverizer Co.—Booth W W-32. One No. 2 Jumbo Junior type crusher with samples of crushed material; photos of recent installations, also operating model of new "Non-Clog" crusher for handling wet, muddy rock. Ray F. Schneider in attendance.

Haiss Mfg. Co., Inc., George

Hanson Clutch & Machy Co.

Harnischfeger Sales Corp.—Booth W W-29. 1-yd. Diesel shovel, ½-yd. gasoline trench hoe, ladder type trenching machine. Outside at 1020 Hamilton, 1½ blocks from auditorium will show 1¼-yd. gas shovel actually digging frosted ground, also truck crane and backfiller. W. Harnischfeger, vice-president, N. P. Farrar and L. N. Ridenour, sales managers, H. S. Strouse, advertising manager and men from all offices in attendance.

The Hastings Pavement Co.—Booth A A-51. Asphalt paving blocks, asphalt flooring blocks. P. L. Thompson, T. J. McNally and G. P. Hemstreet in attendance.

The Hayward Co.—Four Hayward orange peel buckets of varying sizes, two Hayward clam shell buckets and a drag-line bucket. H. M. Davison, General Manager of Sales; H. S. Atkinson, Engineer Clam Shell Department;

P. M. Armstrong, Engineer Orange Peel Department; H. C. Ryder, Sales Department, in attendance.

The Heil Co.—Booth W W-69. Steel dump bodies of three kinds: (1) Batch work with swinging partitions; (2) Combination with removable sides; (3) Light duty for Ford, Chevrolet and Reo. Hoists of several kinds: (A) Hydro twin cylinder to give dump angle 55°; (B) Mechanical; (C) Light duty hand and power snow plow. J. P. Heil, Vice-President; Jos. Heil, G. W. Kuhlman, E. C. Gilmore, Howard Winton, R. L. Dierckemeier, C. G. Eisenberg and R. E. Parmenter in attendance.

Heller Brothers Co.—Booth N E H-14. Masterrenches. C. W. Stone in attendance.

The Heltzel Steel Form & Iron Co.—Booth A A-4. Steel forms for roads, streets, curb, sidewalk, curb and gutter, steel bins, material measuring devices, longitudinal and transverse joint installing machines, etc.—J. N. Heltzel, W. J. Savage, M. M. Bishop, B. M. Clark, George Harm and Joseph H. Gwynne in attendance.

Hercules Motors Co.

Highland Body Mfg. Co., The

Highway Products Co.—Booth A Y-12. A new mechanical distributor for sand, pea stone, gravel, etc. W. Burghardt and A. N. Nickerson in attendance.

Highway Trailer Co.

Huber Mfg. Co.—Booth W W-49. One 10-ton motor (4 cyl.) Roller; one 5-ton motor (4 cyl.) Roller with scarifier and grader blade; one Industrial tractor on rubber treads. A. W. Newby, Vice-President; M. E. Miller, Sales Director, H. A. Devore, A. A. Cooper, F. M. Moyer and H. E. High, in attendance.

The Hug Co.—Booth W W-58. Models 60, 84 and 86 roadbuilder trucks, The Hug subgrading machine, turntable and subgrade template. An added feature to be exhibited for the first time is the new Hug ready mixed concrete rear bottom dump remix body—a new body designed by C. J. Hug for the purpose of handling wet concrete to be delivered from central mixing plants. C. J. Hug, President; R. K. Tibbetts, General Manager and V. H. Koch, Assistant Manager, in attendance.

Hughes-Keenan Co.—New dump body.

The Humphryes Mfg. Co.—Booth E H-44. Double F 4-in. plunger type L. ft. and force trench pump, single high capacity diaphragm pump, double high capacity diaphragm pump, direct connected centrifugal pump.

Hvass & Co., Chas.

Hyatt Roller Bearing Co.—Booth W W-12. Bearings for all types of industrial machinery. F. S. Darke, B. H. Lytle, C. M. Burdette, H. M. Carroll and J. V. Leary in attendance.

Hydraulic Hoist Mfg. Co.—Booth W W-39. St. Paul hydraulic hoists. One of each type and size will be displayed, also a working miniature hoist and body. J. H. Bell, Fred Bell, Jr., V. L. Farnsworth in attendance.

Independent Pneumatic Tool Co.—Booth E H-123. Thor compressor. The compresesor with the super-charger, and a full line of pneumatic contractors' tools. R. S. Cooper, vice-president; M. J. Harkless, E. McKinney, H. F. White, V. W. Robinson, A. Fletcher and R. B. Arthur in attendance.

Indiana Truck Co.—Booth W W-65. Four models, road builders trucks, including a new 7-bag batch contractor's job with dual pneumatic tires and 5-speed transmission, and a 23-ton heavy duty maintenance and gravel hauling truck with 7-speed transmission. H. K. York, Vice-President; H. A. Summerland, C. B. Summerland, R. W. Fish, S. J. Farrell, E. B. Sinclair and L. G. Stewart, in attendance.

Industrial Broundhoist Corporation.—Booth A A-12, Main Arena Floor. One D. C. gas crawler shovel with trench hot attachment; one 7½-ton gas crawler crane. A. L. Harman and J. F. Poland in attendance.

Ingersoll-Rand Co.

Insley Mfg. Co.—Booth W W-66. One Insley shovel, one Insley crane. G. S. Wagner, H. Jameson, A. C. Rasmussen, R. B. Dorward and W. W. Engelking in attendance.

International Harvester Co. of America.—Booth W W-15. International motor trucks: one 2-ton speed dump truck; one 2½-ton dump truck; one 3½-ton dump truck and one 1½-ton speed truck with Flusher sprinkler equipment. McCormick-Deering Industrial tractors; two 10-20 Industrial tractors; one 15-30 Industrial tractor and one McCormick-Deering power unit. W. F. McAfee, motor truck sales and P. Y. Timmons, tractor sales, in attendance.

International Trade Press.—Magazines.

Edw. J. Jackoboice.—Booth E S-28. "Monarch" road maintenance machines. H. E. Price, Edw. W. Jackoboice, Jr., and Edw. J. Jackoboice in attendance.

Jaeger Machine Co.—Booth E S-1. Mixers featuring a new end discharge all purpose road maintenance mixer, known as Speed King, also new Jaeger 10-E paver on crawlers with boom and bucket. A special outfit for not only paving but for sidewalk and curb jobs. Full line of tilting and nontilt mixers, from small handy trailers up to 1-yd. central plant mixers. G. Jaeger, O. G. Mandt, W. M. Simpler and H. A. Frass in attendance.

C. S. Johnson Co.—Booth W W-78. Complete line of bin models, batch measuring hoppers, volume type, simultaneous-volume-weight hoppers. Special batchers. Moisture testers. C. S. Johnson, President; W. T. Brennen, Sales Manager, in attendance.

Jones Superior Machine Co.—Booth E S-4. New Speedster saw table, one super woodworker. H. D. Cameron in attendance.

Joy Manufacturing Co.—Booth A Y-33. Snow loader.

JT Tractor Company.—Booth A Y-4. Central Armory. One model 45, 5-ton, full crawler type tractor. E. H. Browning, president, and Harrison Browning, secretary, in attendance.

Kensington Steel Co.—Booth E H-19. Display of castings and photographs with descriptive literature of parts for contractors' equipment. E. C. Bauer, Vice-President; E. A. Lerner, Sales Manager and Kenneth Jensen, General Manager, in attendance.

Kentucky Rock Asphalt Co.—Booth A A-. Literature and samples of pavement. E. A. Pollard and T. J. Foy in attendance.

Keystone Driller Co.—Booth W W-11. A model 4-28 Keystone excavator, equipped with revised type skimmer scoop, roller bearing type, with electric trip, operating at booth, also two sizes of drop bottom ditcher scoops with attachments and electric trip. A. F. Kroen, J. Walker Wilson, O. D. Hanshew and C. R. Davidson in attendance.

Kinney Manufacturing Co.—Booth W W-35. One Kinney auto heater and distributor. A. J. Munday, W. E. Worcester, H. K. Potter and E. F. Bender in attendance.

Klauer Manufacturing Co.—Booth E-24. A model "Snogo" snow remover, in operation. A large standard machine will also be on exhibit in the yard adjoining the auditorium. W. H. Klauer, president, and R. I. Schuppener, general sales manager, of the Klauer Company, in attendance, with other representatives.

The Knickerbocker Co.—Booth 19-W W. Knickerbocker concrete mixers, 7-S, 10-S, and 21-S. W. W. Knickerbocker, president, and W. W. Du Pre, vice-president, in attendance.

Koehring Co.—Booth W W-48. 27 E paver, No. 501 shovel, 10-S Dandie mixer and subgrade planer.

Kohler Co.

Kwik Mix Concrete Mixer Co.

The Lakewood Engineering Co.—Booth W W-33. Lakewood Type C finisher; Type F screed; adjustable steel subgrader, graderooter, aluminum straight edges, road forms, cars, track and batch boxes; 10-S building mixer, clamshell bucket, floatbridge. Lion Gardiner, T. W. Dieckmann, R. A. MacGregor, I. E. Gaylord, J. F. Docherty, A. F. Deaney, J. H. Campion, A. N. Herrick and others, in attendance.

The John Lauson Mfg. Co.—Booths 33 and 69. Engines, concrete mixers, diaphragm pumping units, plaster mixers, contractors' saw rigs, high pressure contractors' pump with engine. F. H. Edson, sales manager, E. N. Klein, Eastern district manager, A. H. Quade, district manager, in attendance.

Leach Company.—Booth W W-9. Concrete mixers in the following sizes: 4 cu. ft. tilting mixer, 7 cu. ft. non-tilting mixer, 14 cu. ft. non-tilting mixer, mast hoist. E. C. Leach, C. H. Marsh, D. J. Conway and Wesley P. Dalton in attendance.

The LeBlond-Schacht Truck Co.—Booth W W-103. One 2-batch Roadmaker, equipped with pneumatic tires; one 3-batch Roadmaker, equipped with pneumatic tires. A. Staab, N. G. Schacht and B. Gilbert, in attendance.

Lee Trailer & Body Co.

Le Roi Company.—Booth W W-61. Engines. W. R. Karll and others in attendance.

A. Leschen & Sons Rope Co.—Booth E H-12. Samples of the various constructions and kinds of wire rope. C. R. Deam, E. E. Hickok and E. J. Schillinger in attendance.

Lidgerwood Mfg. Co.—Booth E S-40. One 20-h. p. double drum gasoline hoist, one 30-h. p. double drum gasoline hoist, half open auto lubricating block, ¾-yd. scraper bucket.

Lincoln Steel & Forge Co. New road maintainer.

Link-Belt Co.—Booth 7-W W. A Link-Belt crowler crane, Grizzly crawler loader, vibrating screen sand and gravel model, and a Link-Belt anti-friction belt conveyor idler. N. A. Weston, G. H. Olson, A. Eilersgaard, S. L. Haines, G. L. Snider, Enos Larkin, Geo. E. Hoppe, Sr. and Jr., F. B. Caldwell, Harry Strube, R. S. Plumb and L. Z. Howell in attendance.

Littleford Bros.—Booth W W-30. Littleford asphalt melting kettle, maintenance tar and asphalt heater, oil burning Trail-O-Heater, oil burning tar and asphalt heater, OB patrol heater, oil burning tool heater, Littleford squeegee machine, traffic line marker, oil burning units, and asphalt pouring pots and paving tools. L. W. Glaser, J. J. Strobel, H. R. Reynolds, Herbert Haupt and A. G. Schuette in attendance.

Little Red Wagon Co., The

Lombard Tractor and Truck Corp.

Lufkin Rule Co.—Booth E H-2. Steel and woven tape measures, straight and folding steel and wood rules, mechanics' tools, micrometers, steel scales, etc., folding aluminum rules. R. M. Benjamin, A. V. Huss and S. A. McConnell in attendance.

Macasphalt Co.

Maccar Truck Co.

The Macleod Co.—Booth B H-42. Three melting kettles, one new style tool heater, two concrete heaters, two carbide lights, one paint sprayer, one sand blast machine, one markman weigher, three melting kettles. Walter Macleod in attendance.

Macwhyte Co.—Booth E H-33. Several grades of wire rope, such as is used on steam shovels and concrete mixers. Also guard rail cable, such as is used for protecting curves and dangerous approaches on highways.

Manufacturers' Record, magazine.

Marble Cliff Quarries

Marion Steam Shovel Co.—Booth W W-13. Type 7 gas-electric type 440 straight gas shovel and various parts of other size shovels. D. J. Shelton, Harvey Graceley, L. C. Mosley, J. B. Crew, Harry Cox, Grant Davis and others in attendance.

A. S. Marlow.—Booths E H-89 and 109. One 3 in. single MarlO Mud Hog diaphragm force pump, with ball valves; one 4 in. single MarlO Mud Hog convertible diaphragm-plunger force pump, with fully enclosed roller bearing jack; one 3 in. single MarlO Water Hog open diaphragm pump; one 4 in. double MarlO Mud Hog diaphragm force pump. J. W. Olandt and A. S. Marlow in attendance.

Marsh-Capron Co.—Concrete mixer.

Martin-Parry Corporation

Massillon Power Shovel Co., The

McGraw Hill Pub. Co.—Magazines, technical books.

McKiernan-Terry Drill Co.

McMyler Interstate Co., The

W. R. Meadows, Inc.—Sealtight expansion joints. W. R. Meadows, J. E. H. Brown and L. T. Nolting in attendance.

Metal Forms Corporation.—Booth W W-20. "Metaform" road rail, "Metaform" curb and gutter forms, "Metaform" sidewalk forms. R. M. Moss and G. H. Miller in attendance.

Metalrut Co.

Metalweld, Inc.

The Metropolitan Body Co.—Booth E H-77. Metro couplex cab, Metro duplex cab, Metro closed cab. Raymond Hawley, vice-president, H. W. Jefferson, Cleveland manager, in attendance.

Milwaukee Gas Tool.—Booth N E H-3. New concrete breaker.

M. & M. Wire Clamp Co.

Minneapolis Steel & Machinery Co.—Booth E H-79 and 119. Several models of Twin City internal combustion industrial engines using gasoline as fuel. Also Galion-Twin City E-Z Lift road maintainer. The maintainer is made by the Galion Iron Works of Galion, O., and the tractor is a Twin City 17-28 tractor made by the Minneapolis Steel & Machinery Co.

Monarch Tractors Corp.

Moore Speederane Co.—Booth A Y-22. Gas shovel, 1¼ yd. capacity.

Morris Machine Works.—Booth N E H-18. 4-in. portable gasoline engine driven pumping outfit. V. J. Milkowski and A. H. Young in attendance.

Morse Chain Co.

National Brake & Electric Co.

National Malleable and Steel Castings Co.—Booth E S-8. Samples of cast products.

National Paving Brick Mfr's Ass'n.—Booth E S-20. Model of brick road, literature, sample brick. J. W. Breyfogle, E. L. Beller and J. E. Griffin in attendance.

National Steel Fabric Co.—Booth A A-29. National reinforcing, welded steel fabric. Robert L. Glose, sales manager, R. W. North district manager, W. P. Hurst and others in attendance.

N. P. Nelson Iron Works.—Booth A Y-20. One Nelson Fordson crawler loader complete with 1-yd. batch box, one Nelson crawler loader complete with swivel spout and equipped with electric motor. A. A. Nelson and H. Heidelberger in attendance.

Northfield Iron Co.

Northwest Engineering Co.—Booth A A-2. Entire line of Northwest shovels, cranes, draglines and pull-shovels. One of these, as is the usual practice, will be hooked up with power for complete demonstration. The exhibit will be in charge of C. R. Dodge, General Sales Manager, and H. G. Barkhausen and L. E. Houston, President and Secretary and Treasurer, will both be present. The entire sales force will be called in and will also be on the floor during the road show exhibition.

Novo Engine Co.—Booth W W-50. A complete line of industrial engines, 1, 2 and 4 cylinder, 1½ to 50 h. p., hoists and pumps.

Nugent Steel Castings Co.—Steel castings.

O'Connell Motor Truck Co.

Ohio Good Roads Federation

The Ohio Power Shovel Co.—Booth A Y-28.

Line gasoline shovel, Timken bearing equipped. J. D. Rauch and L. A. Marshall in attendance.

Ohio Valley Rock Asphalt Co., Inc.

O. K. Clutch & Mach. Co.—Booth W W-41. One 35 h. p. double drum hoist, one portable elevator, one high speed single drum hoist, one 120 ft. portable air compressor. H. Druschel, manager, W. W. Berchtold and C. W. Ferguson in attendance.

Olsen Testing Machine Co.

Orr & Sembower, Inc.

Orton Crane & Shovel Co.—A Model A ½-yd. shovel and a Model G 10-ton crane with 40-ft. boom and 1-yd. Orton clamshell bucket. P. A. Orton, Herbert Mertz, A. R. Whitney and P. A. Orton, Jr., in attendance.

The Osgood Co.—A 1¼-yd. heavy duty gasoline shovel.

The Owen Bucket Co.—Booth E H-10. Four new types of clamshell buckets, models, etc.—E. W. Botten and H. W. Botten in attendance.

Page Steel & Wire Co.—Booth E H-115. Page Hi-Way guard. W. T. Kyle in attendance.

The Park Drop Forge Co.

Parsons Co., The

Penn Products Co.

Perfex Corporation.—Booth E H-38. Full line of heavy duty industrial type engine cooling radiators. Both cellular and tubular types of cores will be shown. Also the three types of radiator construction: sheet metal, cast tank and the section replaceable unit types. This year a new concrete mixer core will be featured. This is the first year the company has exhibited under their new corporate name as they were formerly the Racine Radiator Company. Roger Birdsell, sales manager; R. W. Wilson, H. L. Zimmerman and A. C. Owen, in attendance.

Perry Company.—Booth N E H-24. Perry automatic scrapers. John Perry in attendance.

Pierce Governor Co.

Pierce Roller Co.

Pit & Quarry, magazine

Pittsburgh Testing Laboratory.—Booth E. H-26. Literature descriptive of inspection service of road materials used in construction and other materials. Specimens illustrative of tests made with interpretations of results. H. H. Craver, A. R. Ellis, N. C. Hoyles, J. M. Moss and T. F. Hindman in attendance.

Plymouth Locomotive Works.—Booth W W-59. 8-ton Plymouth gasoline locomotive, 12-ton Plymouth Diesel locomotive. E. W. Heath, J. L. Smith and G. G. Stein in attendance.

Pontiac Tractor Co.

Portland Cement Association.—Booth A A-11. Recent photographs and colored picture displays to illustrate the use of concrete for city streets as well as highways will form the major part of the exhibit. L. S. Trainor, Manager of Highways and Municipal Bureau, W. E. Barker and W. F. Tempest.

Public Works, magazine

Rail Steel Bar Ass'n—Booth E H-121. Educational film showing manufacture and use of reinforcing bars. Samples of bars. Illuminated exhibit showing various processes of making bars. Literature. H. P. Bigler, secretary, and F. G. Carrel in attendance.

Ransome Concrete Machinery Co.—Booth West Wing 99. A 27-E Ransome paver and a 5-S Ransome standard building mixer and a 3½-S Ransome tilting mixer. J. M. Trevor, A. P. Robinson, G. C. Ellis and J. E. Bushnell in attendance.

Rawls Mfg. Co. Weed mower

Relay Motors Corporation.—Booth W W-73. New Relay Model 30A, 1½-ton chassis showing for first application of relay drive principle to 1½-ton truck. The Relay Model 70A 3½-ton chassis having all-weather cab and LaPlante-Choate snow plow mounted on it. The Garford Model 30 1½-2-ton chassis having all-weather cab and a standard 1½-cu. yd. dump body and hoist mounted on it. A novel demonstration by a miniature Relay truck showing how the Relay drive axle works. W. E. Conway, K. A. Karg, C. A. Boesel, J. M. Van Horn, Henry Wolf, E. H. Lowe, W. J. Baumgartner, W. E. Murphy and Frank E. Borer in attendance.

Reo Motor Car Co.

Republic Iron Works

Republic Truck Sales Corporation, Linn Manufacturing Corporation.—Booth W W-89. Linn tractor with snow-fighting equipment, three Republic trucks. O. W. Hayes, J. C. Haggart, Jr., R. E. DeVogt, A. R. Keagy, W. P. Hanson, G. R. Hanks, H. H. Linn and P. W. Gould in attendance.

Rex-Watson Corp.

W. A. Riddell Co.—Booth W W-93. I. & P. one man graders, new snow plow attachment and new road roller; also Alwaytracs, rigid rail tracks and Cahl tracks.

Rock Products.—Booth E H-14. Display of copies of Rock Products. Ralph C. Sullivan and W. E. Edwards in attendance.

The Roderick Lean Co.—Booth N E H-16. The Roderick Lean "Groundhog" revolving tractor scraper. C. A. Hines, F. H. Cahall and W. E. Orbison in attendance.

Rogers Brothers Corp'n—Booth A Y-24. Central Armory. One 35-ton 6-wheel Gooseneck heavy duty trailer with four rear wheels in line on two rocking axles. Charles A. Rogers and Louis Rogers in attendance.

Rome Mfg. Co.

Root Spring Scraper Co. Truck scrapers

Russell Grader Mfg. Co.

Ryan Manufacturing Corp.—Booth A Y-23, Armory. One 12-ft. Ryan grading machine. R. D. Bartlett, C. B. Faverty, O. Q. Hinds, L. B. Sherman and J. M. Lowry in attendance.

Joseph T. Ryerson & Son, Inc.—Booth E S-10. Reinforcing steel for highway construction and general reinforcing steel products. Also general steel products and small tools for contractors. F. A. Doran, Bill Bryant and Chas. Kehr in attendance.

Sauerman Bros., Inc.—Booth E H-30. Working models of Sauerman power scraper and slackline cableway. Sauerman cableway bucket and carrier. Crescent scraper and miscellaneous accessories; also a new type wire rope block and slow moving pictures of levee construction work as accomplished with Sauerman power drag scrapers. J. A. Schultz, L. E. Dierks, J. L. Nellis, J. N. Schufreider, C. C. Bauerlein and D. D. Guilfoil in attendance.

The Gustav Schaefer Wagon Co.—Schaefer automatic one-man tractor scrapers, 4, 5, 6 and 7 ft. wide, also the new No. 8 road builders model for Best Sixty tractor (capacity 2 yd.) There also will be two Schaefer motor truck winches and roll-off lumber bed equipment. Ralph J. Hanger in attendance.

Schramm, Inc.—Booth W W-14. Air compressor mounted on a motor truck and complete engine driven unit mounted on all metal wheeled truck. Henry N. Schramm, president, A. O. Witt, manager sales promotion, and four other regular salesmen in attendance.

Selden Truck Corp.—Booth W W-105. Two road builders trucks, Model 2X, 1½ yd. or one 7-bag batch load, Model 4X 2½ cu. yd. two 7-bag batch loads. C. G. McDonough, W. I. Jordan, W. L. Poffinberger, G. W. Poyzer, H. E. Zimmerman, in attendance.

Servel Mfg. Co.

Servicised Products Corporation. Expansion joint.

Shaw Enochs Tractor Co.—One Shawnee McCormick Deering powered grader, one Shawnee cletrac powered grader. A. B. Rhoades, J. L. Becker, Z. H. Hutchinson, A. R. Glasrud in attendance.

Sheet Concrete Pavement Corp. of America

Simons Paint Spray Brush Co.—Booth E H-29. Spray brush equipment, portable air compressors, zone line marking machine for streets and highways and several attachments for producing clean, dry air and eliminating oil and water from the air line prior to serving the spray gun. George W. Simons in attendance.

The Simplex Piston Ring Co. of America, Inc.

Sivyer Steel Casting Co.—Booth A A-19. Rough and machined alloy steel castings for road machinery and allied industries. Arthur H. Oberndorfer, advertising manager, Lamar S. Peregoy, vice-president, and Martin A. Fladoes, sales manager, in attendance.

The T. L. Smith Co.—A 27-E paver of completely new design; also a 7-S mixer on crosswise trucks. Geo. W. Pollock in charge.

Smith Engineering Works

Snap-on Wrench Co.—Booth E H-50. Complete line of Snap-On interchangeable socket wrenches from ¼ in. to 1½ in. Standard S. A. E. and U. S. Standard sizes. An electrically operated demonstrating device will be used to show the construction and operation of the ratchet. In addition there will be a complete showing of Blue Point open end wrenches and a new type of Blue Point Boxocket wrenches, Simplex open end ratcheting wrenches, pipe wrenches, chisels, punches and other hand tools. Several important new additions to our line will also be shown for the first time C. H. Tennyson, E. A. Glenn, and salesmen from Cleveland branch office, in attendance.

Solvay Sales Corporation.—Booth E S-30. Solvay flake calcium chloride and apparatus developed for its proper use. W. I. Galliher, G. H. Kimber, H. F. Clemmer, H. P. Grissmer, P. M. Goodwin, C. M. Adams, Jr., Geo. C. Schroeder, H. E. Hattersley, S. O. Taylor, V. R. Ewing and G. P. Spencer in attendance.

South Bend Lathe Works.—Booth W W-117. South Bend motor drive lathe, South Bend brake drum lathes, South Bend screw cutting lathes. R. Young, M. W. O'Brien, J. J. O'Brien, R. E. Frushour, L. O. Stephenson and R. C. Erhardt in attendance.

Speeder Machinery Corporation.—Booth A A-8. One standard ½-yd. high lift crawler type shovel, one standard improved type crawler type skimmer scoop, one standard 30 ft. crane attachment, one standard pull shovel attachment. T. M. Deal, Glen D. Cooper and Edgar McNall in attendance.

Splitdorf Electrical Co.

Standard Gas Engine Co.

Standard Scale & Supply Corp., The

Star Drilling Machine Co.

Stockland Road Machinery Company

Stover Mfg. & Eng. Co.—Booth E H-67. Internal combustion engines. Lee Madden, vice-president, F. J. Haller, chief engineer, V. L. McKinstry, Eastern representative, W. S. Walker, Western representative, in attendance.

Stoves Mfg. & Engineering Co.

Streich & Bro. Co., A.

Sullivan Machinery Co.—Booth W W-40. A Sullivan "WL-22" semi-portable direct motor-driven compressor of a new type, will supply compressed air power to the concrete testing block, where Sullivan concrete breakers, clay spaders, and several types of new rotator hammer drills will be shown in operation; to the Sullivan Turbinair Portable Hoist which will be shown illustrating its lifting and hauling power; and to the Sullivan Drill Steel Furnace operated by gas, and Sullivan all-hammer portable drill sharpener, which will be demonstrated by an experienced blacksmith in making drill bits and shanks for rock drilling work. In addition, a Sullivan scraper hoist of 25 h. p. will be shown in operation. Also Sullivan vibrationless portable compressors in two sizes, namely the 310 ft. WK-314 4-cylinder V type balanced compressor, and the WK-110-ft. 2-cylinder, vertical machine, both operated by reliable Buda engines, direct connected. Exhibit in direct charge of Ralph T. Stone, Manager of the Company's office at Cleveland, assisted by Ray B. Hosken, General Sales Manager; Joseph H. Brown, Sales Manager for Chicago; W. R. Jarvis, Sales Manager for Pittsburgh; and by Messrs. W. H. Duffill, Detroit; H. E. Butters, Oscar R. Cundy, Pittsburgh; and Chester G. Cummings, New York City.

Superior Body Corp.

Taylor-Wharton Iron & Steel Co.

Tennessee Tool Works

The Texas Co.—Booth A A-25.—A corps of specialists on the various forms of asphalt road and street work will be constantly at the service of engineers, contractors and public officials. They will gladly discuss specific street and highway problems and offer suggestions. A series of booklets dealing with the principal divisions of asphalt construction, surface-treating, patching, etc., may be obtained at the booth.

Textile Bag Mfgrs. Assn.

The Thew Shovel Co.—New back digger attachment for Lorain 75 shovel. R. H. Wilson in charge.

The Timken-Detroit Axle Co.—Booth W W-115. A display stand on which are mounted worm gear driving units of from ½ to 7½ ton capacities. Also a front and a worm drive rear axle of the type used under a 2 cu. yd. dump truck. Also a worm gear and a worm shaft that has given 585,000 miles in hard service and still appears good for an equal additional distance. J. S. Wardwell, Western Representative; C. S. Dahlquist, Sales Engineer, in attendance.

Timken Roller Bearing.—Booth E S-7. Assortment of the various types of roller bearings suitable for use in different kinds of road building and maintenance equipment, pavers, rollers, cement mixers, etc. L. M. Klinedinst, J. W. Weir, G. D. Thewtis, H. P. Proffitt, M. H. Kuhl, S. C. Partridge, B. E. Keifer, R. W. Ballentine, and R. P. Kelley in attendance.

Toledo Pressed Steel Co., The

Trackson Company.—Booth W W-25. Model F Standard Trackson, full crawler for Fordson; Model D heavy-duty Trackson full crawler for Fordson. W. H. Stiemke, general manager, H. D. Van Doorn, assistant manager, L. E. Dauer, sales manager, S. B. Bragdon, service manager, R. D. Houghton, export manager, in attendance.

Truscon Steel Co.—Booth A A-3. Welded steel fabric; dowel contraction joints, curb bars, road forms, reinforcing steel. B. C. Briody, manager of highway department, in charge.

Twin Disc Clutch Co.—Booth E H-125. One power take-off unit 14-in. double clutch, square pin drive; one power take-off unit 10 in. single clutch, Timken equipment; one power take-off double plate 11½-in. clutch, square pin drive type; one B-2 11½-in. clutch, square pin type; one 8-in. clutch; one 18-in. clutch, square pin type; one 11½-in. clutch. G. M. Guilbert, sales manager, R. H. Smith, sales engineer, and J. B. Jenkins, sales engineer, in attendance.

The W. S. Tyler Co.—Hummer electric screen, Rotap testing sieve shaker, woven wire screens. A. E. Reed, C. T. Bingham and W. J. Piggott, in attendance.

Universal Crane Co.—Booth A A-10. Two 6-ton cranes, one showing motor truck crawler attachment, the other a 52-ft. boom. F. A. Peck, vice-president, in charge.

Universal Crusher Co.

Universal Motor Co.—Booth E H-35. Industrial engines (gasoline driven); electric generating plants (gasoline engine driven); centrifugal pump sets (gasoline engine driven); electric welder units (gasoline engine driven.) V. H. Garrison in attendance.

Universal Power Shovel Co.—Booth A Y-18. Standard Model B Wilford shovel, and possibly one other unit. Also photographs of Wilfords in many different types of work. William Ford,

President; D. H. Millard, Vice-President, and Frank Temple, Secretary-Treasurer, in attendance.

Wallace & Tiernan Co., Inc.

Walter Motor Truck Co.

Waukasha Motor Co.—Booth A A-35. Industrial power units and engines. P. C. Ritchie, advertising manager, O. Pederson, service manager, J. E. DeLong, F. P. Wilkins, C. B. Stebbins, J. G. Swain, J. M. Boorse, J. B. Fisher, chief engineer, and L. Bower, inst. engineer, in attendance.

Wausau Iron Works

Wehr Co.—Booths E H-36 and 20. Three models of "One Man Power Graders," two models tractor powered road rollers, 3 to 10 ton. Wehr Special Crawlers for use with one man power graders, and "Wehr Fordson Truck-Tractor." E. C. Myers, E. R. Wehr, G. C. Salisbury in attendance.

Western Crucible Steel Casting Co.—Booth E H-87. Various different Westeeco products, such as dipper teeth and bases, tractor parts, trench teeth, snow plow parts and various other parts that are subjected to abrasive wear.

Western Wheeled Scraper Co.—Booth A A-22. 7-yd. Western crawler dump wagon; new model road grader; "Western" hot patch asphalt outfit.

The White Company.—Booth W W-6. Model 51-A, 2½-ton, two-batch dump truck; Model 52, heavy duty dump truck chassis with auxillary transmission for extra-low gear operation in soft ground and excavations with steep grades and under heavy loads; Model 15-B, one-ton dump truck with hydraulic underbody hoist, specially adapted to road maintenance work. Also a heavy duty double reduction rear axle unit with housing cut away to show working parts. Sales promotion manager, L. G. Avery, sales engineers, H. P. Starbird, J. N. Bauman, V. W. Fries, G. R. Bryan, R. W. Knowles, V. F. Curtis and W. A. Maynard in attendance.

Whitehead & Kales Co.

Wiard Plow Co.

Wickwire Spencer Steel.—Booth E H-15. Clinton welded fabric, road reinforcement, wire rope, highway guard. R. J. Southwell, W. B. Underhill and E. L. Stevens in attendance.

G. H. Williams Co.—Booths E H-49 and 53. Favorite clamshell bucket, drag line bucket, automatic derrick model operating miniature bucket. T. D. Harter, W. C. Swalley, C. F. Weibler, G. S. Swanson, H. B. Ackland, R. B. Randall and A. J. Sichtinger in attendance.

Williams Patent Crusher and Pulverizer Co.—Crushers, including new crusher designed for crushing muddy rock without choking.

Williamsport Wire Rope Co.

Wisconsin Motor Manufacturing Co.—Booths E H-85 and 113. Models X 4½x5, 4 cylinder; B-2 5¼x6½, 4 cylinder; H 4x5, 6 cylinder. Mr. Fitzgerald in charge.

Wood Hydraulic Hoist & Body Co.—Center of West Wing. Full size exhibit model of underbody hydraulic hoist and steel body on revolving platform. Miniatures, complete in every detail, electrically operated of mechanical hoist and body, speed hoist and body, hydraulic hoist and body. Self dumper. Logan Wood, F. H. Dewey, C. D. Macpherson, H. Krindlog and others in attendance.

Alan Wood Iron & Steel Co.—Booth E H-71. Model miniature bridge floor with installation of "AW" diamond pattern rolled steel traffic treads for electrically operated truck in demonstration of actual bridge conditions. I. M. Smith and J. R. Jones in attendance.

Wyoming Shovel Works, The

Young Radiator Co.—Booth E S-11. Radiators for heavy duty service. F. M. Young, President; J. J. Hilt, Sales Manager; W. H. Schleck, Secretary and Treasurer; D. A. Hisey, Superintendent; L. A. Pfost, Sales Engineer and W. C. Klespe, Engineer, in attendance.

Zenith Detroit Corp.—Booth A H-9. Carburetors and fuel filters. V. I. Shobe, Assistant General Manager and Sales Manager, and C. C. Sard, Branch Manager, in attendance.

Third Annual Southwest Road Show and School

Preparations are being made for the biggest and best road show and school ever held in the Southwest—the Third Annual Southwest Road Show and School—which will be held at Wichita, Kan. for four days, beginning Feb. 21st, 1928. This show, which started in a small way two years ago, has grown in popularity and now covers a territory of over 14 states. An extensive Federal Government Exhibit will comprise one section of the show, and in addition, a number of states departments will have their own exhibits.

All indications point to a record attendance—more than double that of any previous year. The management of the show has succeeded in securing the co-operation of the railroads, which will grant reduced rates, and the leading hotels, all of which will do their best to provide adequate accommodations for all those attending, as no other conventions or meetings will be scheduled for the week of the show.

Reservations have already been made by a large number of the leading manufacturers and distributors of road building and Maintenance, as well as construction machinery, materials and equipment. In fact, Wichita's great Exposition Building has already been found too small to take care of all of the applications, and additional floor space in the Coliseum adjoining the Exposition Building has been arranged for, to take care of the overflow.

Conduct of Road Engineers

Advice to Field Men Taken from Field Manuals of Highway Commissions

Points like these have inestimable value if carefully observed by field men. The public with whom the greatest number of contacts is made from an opinion on policy of state road work from these contacts. It is their only touch with the administration of their tax money for road work.

Massachusetts.—Resident Engineers and assistants must remember that they are employees of the Commonwealth of Massachusetts. While they may hold subordinate positions, they are nevertheless representatives of the State Department of Public Works and are under direct observation while in any community. Both when at work and off duty their personal conduct should be such as to cause no criticism, for they are regarded as holding positions of considerable importance, when in charge of work. A conscientious effort must be made to co-operate with all the local officials with whom they come in contact, for it is many times this co-operation or lack of co-operation that determines the position of the Department in that community. A man's ability to leave a favorable impression with the people with whom he comes in contact is sometimes of as much importance as his technical ability.

Michigan.—Engineers of the department must remember that they are employees of the State of Michigan, and, whatever their position, are representatives of the State Highway Commissioner. While in any community they are under the direct observation of the people of that community. While at work and off duty employees must conduct themselves so as to uphold the dignity of the department and avoid adverse criticism. People of a community are naturally interested in road work in their locality and ask numberless questions. They should always be answered courteously. A man's ability to leave a favorable impression with the people with whom he comes in contact is of considerable importance. Your methods of work are given you from Lansing and when these are questioned by local people they should be informed that you are working under orders which can be changed only from Lansing. Party chiefs and others must not write any letters or give out any information relative to the work of the department to people outside of the department. All such requests should courteously be referred to the Lansing office, as discreet ignorance of what is contemplated is essential, as far as outsiders are concerned. All men will maintain discretion in their conversation in order that they do not say too much.

Arkansas.—Treat the public with every possible courtesy. Remember, that the public in general is your employer, and that this courtesy is due. There will be times when it will be difficult to observe this, but do all you can to avoid arguments and disturbances.

Minnesota.—The success of the work, throughout the State, is dependent largely upon the courtesy and business-like manner in which our field men meet the public. The desire of the Department is to promote a feeling of confidence and goodfellowship between the local officials and the personnel of the Department. Therefore, it is required that each one co-operate and conduct himself and his work in such a manner as to further the success of the Highway Department, and return to the people of Minnesota, dollar value for dollar invested.

California.—Relations with the public should be courteous but businesslike and always governed by common sense. Public discussion of the policies of the Highway Commission should be avoided. Remember, always, that you represent the State of California, and that the state and the people of the vicinity will hold you responsible for seeing that the work is accomplished in such manner as to afford greatest benefit and least inconvenience to the public at large.

Wayne County, Mich., Has Spent Over $42,000,000 on Its Road Program.—Twenty-one years ago the citizens of Wayne County, Michigan, voted to adopt the county roads system and created a Board of County Road Commissioners. At that time there was not a mile of improved roads or a modern bridge in the county. Up to Aug. 31, 1927, the sum of $42,390,514 had been spent, and as a result the county has 506.9 miles of improved roads.

Chicago Advocates Progressive Control System

While Other Systems Are Used by Park Boards, the Progressive System Appears to Keep Traffic Moving in Loop Streets—Outlying Systems to be Tied In—New Traffic Commission to Corelate Different Systems Now Being Formed for Metropolitan Area

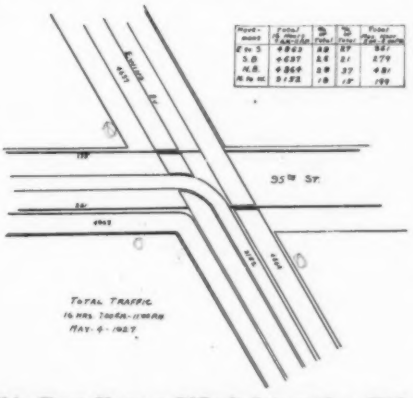
Just as have other communities, and as have the nation's traffic and highway authorities, the city of Chicago has come to realize the great need for traffic control, and the necessity for putting the control onto a sound and logical scientifically planned and administered basis. This need for control of traffic has arisen from the congested condition of the streets that increases at a rate far greater than can be provided for by the opening up of new pavements and the widening of existing ones.

The first efforts at traffic control took the form, as elsewhere, of posting policemen at the crossings, armed with an ear-splitting whistle and a copious and positive vocabulary, as well as a great presence of mind. Up to but a short while ago these capable men did duty at all congested intersections, trying to keep things moving as best they could. Violations continued in spite of their efforts, and traffic jambs seemed the order of the day. At State and Madison, locally called "The World's Busiest Corner," as many as four or five men were needed at times of greatest congestion. The traffic violation slip, handed out to violators, was often disregarded. Accidents were many.

The Department of Streets and Alleys then took over the problem, insofar as it concerned those streets not under the control of the various park boards, and put a man in charge who had an established reputation as a traffic engineer. This man, Mr. Leslie Sorensen, employed a staff of men and put them to work making an extensive traffic survey of the streets upon which some sort of system could be based.

After duly investigating the situation, the city decided that the so-called synchronized light system was becoming obsolete and that the progressive system should be adopted. This system, with each light timed according to the traffic at each intersection, operates upon the basis that a car starting at the edge of the system and traveling at a predetermined rate of speed, will encounter the green light at each intersection and will therefore find it possible to proceed in one direction through the entire system without interruption. A lower or higher speed will not give this result, and the wise driver soon finds himself conforming to the rate of speed that has been found to give safety on that particular street, since at that speed the best time may be made, while with the synchronized system speeding was encouraged and accidents were not reduced.

Loop District.—A total of 53 intersections are controlled by this system in the downtown district known as the loop, bounded by the loop made by the tracks of the elevated lines. Since these streets are laid out on the rectangular basis, the intersections are easy ones to control. Four lights have been installed at each intersection, one for each traffic lane. These are all controlled by a central board in the basement of the City Hall. A master control knob controls every light in the area, and one twist of this can stop all traffic instantly. Too, this board provides for the control of each individual light with the changing of a timing



This Chart Shows a Difficult Intersection, With a Heavy Left Turn Traffic. The Best Control Was by a Light at the Lower Left and Light at Lower Right Working Together and Light at Upper Left Alone Controlling Inbound. Ewing Avenue, Traffic to Avoid its Touching the Left Turn Traffic

device so that the cycle of any light can be changed at will without the use of any tool. This central control provides for any emergency, and can give right-of-way to fire apparatus on any street without danger from cross traffic. In addition, an adequate force of traffic police at each intersection can deal with local emergencies, see that the lights are obeyed, enforce turning and parking regulations, and take care of other normal police duties at the intersection. These men on foot are aided by a corps of mounted police who constantly patrol the streets and aid when jams occur between intersections.

Time Intervals.—The three light system is used. The red light brings traffic to a stop, a green light signals a forward movement, and an overlapping orange light permits clearing the intersection at each change and gives warning to pedestrians and drivers of an impending change. This orange light is so timed as to not only permit clearing the intersections of vehicles moving in one direction before the opposing traffic is started, but it is supposed to give pedestrians adequate opportunity to reach the nearest curb before counter traffic starts. Left turns are prohibited, as are U turns at the intersection. Right turns still present some hazard to the unwary pedestrian, especially to the woman shopper who is notoriously slow in crossing the street, and who usually will not proceed to the nearest curb should such movement mean turning back and waiting for the next traffic change.

The controls in this loop district are normally set for cycles the following duration:

Sunday and Holidays

		Cycles
6:00 P. M.—	8:30 P. M.	60
8:30 P. M.—	12:30 P. M.	50

Otherwise not operative.

Monday to Friday, Inclusive

		Cycles
7:30 A. M.—	8:00 A. M.	60
8:00	9:00	65
9:00 A. M.—	4:30 P. M.	70
4:30 P. M.—	6:00	75
6:00	8:30	60
8:30	12:00 Midnight	50
12:00	7:30 A. M.	Not operative

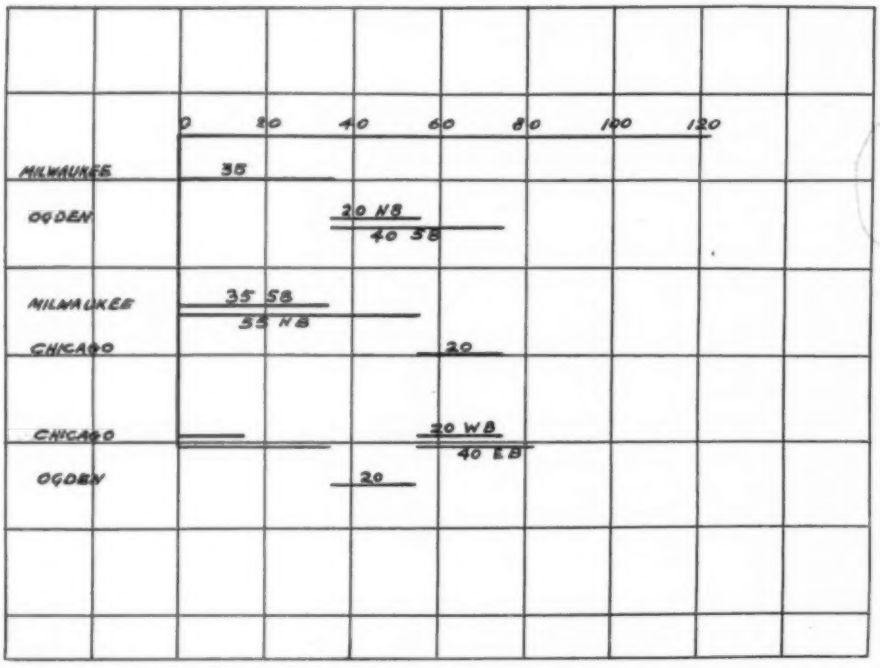
Saturday

		Cycles
7:30 A. M.—	8:00 A. M.	60
8:00	9:00	65
9:00	12:00 M.	70
12:00 M.	2:00 P. M.	75
2:00 P. M.—	4:00 P. M.	70
4:00	6:00	65
6:00	8:30	60
8:00	12:00 Midnight	50

12:00 Mdnight—7:30 A. M. Not Operative

The arrangement of the three divisions of each cycle varies with the traffic carried by the street, since some streets carry a greater traffic than others, and the nature of the traffic on one street will not be entirely the same as the nature of the traffic on another street. At some intersections, provision has been made for turns that must be made by street cars, as well as for any other unbalanced traffic movement that may be revealed by the traffic survey for that street.

Outlying Systems.—The same office has control of two outlying systems now operating and one other in the course of installation. These are now controlled by centrally located master chronolizers and are of the progressive type, but the capacity of the central control board in the loop is being doubled, and these systems will soon be made a part of the central system In addition are a number of synchronized type installations under the control of the various park boards, and in no way a part of the system managed from the City Hall. Other systems of various types are maintained by the outlying communities. The city also has 285 intersections guarded by lights operating on fixed cycle under isolated control. Here, provision has been made for manual control in case of emergency. These will all ultimately be taken into the central system when



This Cycle Arrangement, Based on 75 Cycles, Resulted in a Badly Confused Condition of Traffic. The Chart Below Shows how the Situation Was Corrected

the traffic control system reaches that point.

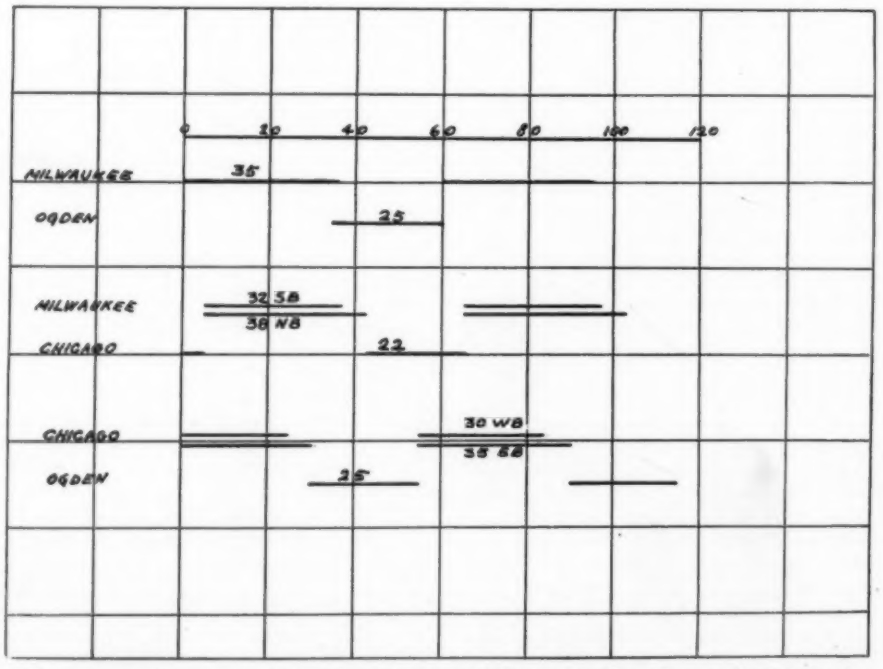
Equipment Used.—While the central system in the main business district has been installed with equipment designed by the city and manufactured to order, the outlying installations under City control were secured upon the market from representative manufacturers. The central control board in the City Hall is said to be the most elaborate control panel in the world, and the first of great size to give such complete control of the system. The capacity of this board is now being doubled in order to permit enlargement of the control territory.

Getting Traffic Data.—The city maintains a force of from 12 to 16 men checking traffic at the various intersections to make sure that the existing control system is working to the best advantage, and to determine control measures needed at intersections not yet so controlled. No system will be installed at any intersection until at least 16 hours of traffic observation has given data upon which to base the control of that intersection. Where traffic movement appears complicated, especial attention is given to turning traffic. An accurate tabulated count is made for each hour of the day, showing types of vehicles and their movements and speeds. Charts are then prepared, and a cycle diagram is then made to provide for the best handling of this traffic. Where a preponderence of traffic is found to be in one direction at an intersection that can not be tied into the nearest control system, the solution often lies in stationing a traffic policeman at that intersection to control the traffic until later conditions justify a light system.

In addition to this form of traffic control, the city installs and maintains a large number of warning signals of the flash type where special hazards occur. These form an effective warning for those locations remote from a control system. These are of the battery type, since no laterals are then needed, installation provides for easy change to the other system, and since salvage value is high.

Since a traffic control system is used to supplement the work of the police department in speeding up traffic and preventing accidents due to poorly controlled or uncontrolled traffic, the true tests of the worth of a system lies within the results gained. In Chicago's loop, in spite of a large increase in traffic during the past year, traffic movement has been speeded up from 20 to 50 per cent, in the area controlled by the central system, and accidents have been reduced 30 per cent.

No Parking.—A new experiment is now to be tried to still further increase Chicago's traffic movement. The City Council has passed an ordinance prohibiting all parking in the business district during the business day. Provisions have been made for taxicabs, buses, ambulances, and for public vehicles when on duty, and parking is permitted from 6:30 P. M. to 7:30 A. M. every day, after 3:00 P. M. on Saturdays, and at any time on Sundays and Holidays. This ordinance is based upon the fact that hitherto legal parking space on the streets within the district could accommodate hardly more than 1,000 cars, that space not now used for parking within and nearby but off the streets could accomodate but 2,000 more, and that the total number of vehicles moving into the loop during the business day averages 180,000 cars. Of this number, 138,000 are passenger cars. Thus but a very small percentage can find a parking space, and the rest must keep on the move, finding it difficult to take on or discharge passengers when both curbs are lined with parked vehicles, and when a second line is attempting to load or unload outside this lane. Thus, too, from two to three traffic lanes on each street are devoted to purposes other than the actual moving of traffic, greatly slow-



When Three Pieces of Control Equipment Were Added to the Apparatus at the Intersection Shown at the Top of the Page, and the Timing Based on 60 Cycles as Shown, the Traffic Jams Were no More to be Observed

ing up the progress of everyone. Too, the result is a slowing up of fire apparatus that may be on the way to a dangerous fire, and these delays cause great financial loss to taxpayers every year. The purpose of the ordinance is thus to remove these obstructions to traffic cause by a small minority in order to aid the great majority and speed up the traffic. It will be interesting to observe the result and see how it coincides with the theory upon which the ordinance was based.

A New Traffic Body.—Because of present widely scattered traffic authority inside the metropolitan district, and inside the corporate limits of the city itself, there has been a lack of coordination of traffic control, with resultant confusion. In order that this situation may be overcome, and a coordinated control and set of regulations promulgated and enforced, the officials of the various park boards, the city, the county, and a number of outlying communities, have formed a new organization, duly empowered by law to make findings, to prepare and enforce rules, and to otherwise act to the end that a coordinated traffic control system can ultimately be put into use. This organization, known as the Greater Chicago Street Traffic Commission, has so far been organized or legal representatives of the City of Chicago, the Chicago Plan Commission, the Municipal Courts, Cook County, the South Parks Commissioners, the West Parks Commissioners, and the Lincoln Park Commissioners. Commissioner of Public Works Wolff, of the City of Chicago, has been elected Chairman, Mr. Simpson, of the Chicago Plan Commission, has been made vice chairman, and Mr. Sorensen has been made executive secretary.

Three major sub committees have been appointed and have started work. The first is the Committee on Uniformity of Traffic Signs and Signals, the second is that on Uniformity of Traffic Regulation and Direction, while the third is that on Uniformity of Traffic Law Enforcement.

The program calls for immediate scientific study, followed by immediate action, and the area covered may ultimately embrace all communities in the metropolitan area.

Pavement Markings at Railroad Crossings.—The Committee on Administration of the American Association of State Highway Officials in its report presented last October at its annual convention of the association recommended for pavement markings at railroad crossings two 2-ft. across-pavement bars 100 ft. from the crossing and two similar bars 500 ft. from the crossing, with the addition of the letters "R. R." between bars. A 10-ft. spacing of bars was specified.

Tips for Inspectors

Inspectors are not expected to burden their memories with a lot of technical specifications. They should keep the specifications contract and construction manual handy for ready reference on some particular point. The exercise of common sense and firm good judgment are attributes of a good inspector. The following is taken from the Construction Manual of the Minnesota State Highway Department.

Do's and Don'ts.—Don't carry a chair. A good Inspector wears out the knees of his trousers and the soles of his shoes.

Be friendly with everyone on the job; familiar with no one. Familiarity dulls the edge of an Inspector's authority.

Be courteous to visitors. Future construction depends upon public good-will. Do not prejudice the public against road improvement by flippant answers to what may seem to be foolish questions.

Orders should be given to foremen, superintendent or contractor only. This rule does not apply to things of minor importance such as the correction of form alignment, elimination of high or low spot in the subgrade or other routine matters. In such things it is proper for the Inspector to call the defect to the attention of the workmen responsible for that particular part of the job.

Do not waste workmen's time by carrying on a conversation with them.

Be severe at the beginning of the job. An erroneous method is more easily corrected the first time it is practiced than after it has been in use, and the reputation of being slack or easy, though it is quickly attained, is hard to overcome.

An Inspector usually enforces his commands through personality. Be sure your judgment is so cool, fair and impartial and your knowledge of the work so thorough that you command respect and obedience.

Don't argue. Refer disputed questions to your superior and until you hear from him, use your own best judgment.

Aid the Contractor at every opportunity so long as it does not affect the quality of the pavement adversely.

The first batch of the day is the one most likely to be bad. Be there to see it mixed.

The last work of the day is most likely to be poorly finished. It should be checked before you leave.

Do not try to magnify your own importance by telling outsiders of the errors you have corrected or of the "crooked work" you have uncovered. The quality of the completed pavement will measure your ability and will be your strongest testimonial.

Proper inspection is a man-sized job. It requires constant vigilance, diplomacy and good old-fashioned backbone. Good inspection may add several thousand dollars to the value of the road without adding materially to its cost.

Erection of Steel.—When the Contractor is ready to erect steel, it is well for the Engineer to set grades for camber blocks. The steel trusses should be bolted up snug with erection bolts in half the rivet holes, while on the camber blocks. The bottom chord connections should be riveted up when on blocks, then swinging the span and riveting the top chord connections. This method insures proper camber in the bottom chord and also snug milled joints at the top chord splices. Securely bolting up joints with 50 per cent of the holes filled with erection bolts is an assurance against loose rivets caused by driving adjacent rivets. All rivet holes into which a cold rivet cannot be placed shall be reamed before riveting up.

Rivets shall be thoroughly inspected by eye inspection first, and then by tapping with a light steel hammer for looseness. All defective rivets shall be promptly marked for removal by making a ring around such defective rivets with a yellow crayon. Rivets in each panel point shall be inspected before riveting gang remove their scaffolding to another point. It is unfair to ask a contractor to erect his scaffolding twice in one place. When tapping rivets with a small hammer to detect looseness, it is well to touch with the bare finger, the opposite head of the rivet unless considerable experience has been obtained in denoting looseness from the ring of the hammer when the rivet is struck a light blow. Defective rivets may be classed as follows:

1. Loose rivets.
2. Rivets in which head is not in contact with the plate for the full diameter on the bucked-up side.
3. Rivet in which driven head is not in contact with the plate for the full diameter.
4. Burned rivets. Caused by overheating. Brittle.
5. Split rivet head. Caused by overheating and being driven too cold.
6. Soldier cap rivet. Caused by excessive length rivet, giving a lip around the head of the rivet.
7. Rivet with unfilled head. Caused by too short stock in the rivet.
8. Spherical head rivet. Caused by driven too cold.
9. Rivet being driven when plates were not drawn up properly and metal is wedged in between plates.
10. Head of rivet not concentric with axis of rivet.
11. Caulked rivets. Loose rivets which may have been caulked so as to appear and sound tight. May be done by tilting the air-gun or snap at an angle when driven or using a cold chisel to caulk down the lip of the rivet head.

Signals for Use on Survey Work

Instructions to Survey Parties Given in Standards of Division of Construction of Indiana State Highway Commission

On survey work considerable communication must be done by means of signals. Such should be as simple and unmistakable in meaning as possible and known to all members of the party. The following are suggested for use, many of them being long established practice:

Extending both arms horizontally once, or waving them once slightly above or below horizontal: "ALL RIGHT". (Close-up signal).

Waving one or both arms back and forth over the head holding a red or white flag, etc., in the hand: "ALL RIGHT." (Distance signal).

Both arms extended downward, diagonally, and raised, extended, to nearly meet over the head, then dropped to downward position again, repeat second time: "ALL RIGHT, COME AHEAD".

Running back an forth in a direction perpendicular to line, at same time waving, in big circle, arm holding flag of some kind: "ALL RIGHT, COME AHEAD" (Long distance signal).

Extending or waving one arm out away from one: "MOVE OVER IN THAT DIRECTION." (Close-up signal).

Waving arm (holding flag in hand) to one side, in circle, so that flag moves away from one at top of circle toward desired direction of move: "MOVE OVER IN THAT DIRECTION." (Distance signal).

Extending arm vertically, holding position a moment, then dropping vertically, repeating until seen: "ROD UP"

Extending arm vertically, holding position an instant, then making short wave toward one side "PLUMB ROD IN THAT DIRECTION."

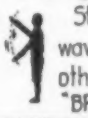
Holding arms, or flags, crossed, motionless, over head: "CAN'T SEE YOU."

(Transitman) extending arms horizontally, one at a time, and drawing them back, alternating, repeatedly: "TAKE SECOND POINT FOR DOUBLE CENTER"

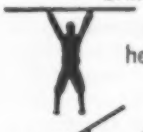
Extending arms horizontally, holding upper arms rigid, waving forearms up toward head and back down repeatedly: "COME THIS WAY AND BRING EQUIPMENT."

Extending arms horizontally, holding one rigid, waving forearm of other toward head and back down repeatedly: "BRING STAKES".

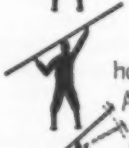
Extending arms horizontally, holding one rigid, waving other downward and back, repeatedly- waving right arm: "BRING WOOD HUB"- waving left arm: "BRING IRON PIN."



Standing sidewise, arms extended forward, wave them up and down, raising one while the other is being lowered, in a chopping motion: "BRING CUTTING TOOLS" (axes, cornknives, etc.).



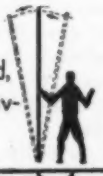
Holding flag rod horizontally over-head: "GIVE ME LINE FOR A HUB".



Holding flagrod on about 45° slant to horizontal, over head: "GIVE ME LINE FOR A TACK".

Holding flag rod on a slant over head, repeatedly raising and lowering upper end: "GIVE ME SECOND TACK POINT FOR DOUBLE CENTER."

Holding flag rod vertically, moving it up and down; or, holding flag rod vertically with bottom on point, moving one hand, or a flag, up and down before it: "SET ON THIS".



Holding flag rod vertically with end on ground, waving top too and fro across the line: "GIVE ME LINE"

Holding flag rod horizontally over head, moving it up and down rapidly "Double center line for hub".

Holding flag rod on a slant over head, repeatedly raising and lowering whole rod: "GIVE ME DOUBLE CENTER TACK POINTS"

Holding flag rod over head, raise and lower ends, rotating about center of rod held at a point: "REPEAT COMPLETE OPERATION."

In giving signals care should be taken to give them in the best manner to be seen; movement of arms should be greater and wider as distance increases; flags should be such as will show up against the background (as for instance white or bright red against green or dark background but darker colors, as a black hat, or something large and opaque, against a bright sky). If possible always stand out in the sunlight when signalling, also where possible stand on a high place where the sky will be the background. In getting line for a point with the rod let sunlight fall on rod if possible; using pencil or plumb cord sight hold contrasting background behind them, as a white page of a note book behind pencil, or black boot top or trouser leg back of white bob cord or yellow pencil. An army sergeant's whistle is sometimes useful to the instrumentman for signalling.

What's New at the Road Show

Brief Descriptions of New Models of Equipment Reported by Exhibitors That Are to Be Observed in the Exposition at Cleveland This Month

Each year brings new and improved equipment for the highway builder, designed and constructed by the equipment manufacturer to the end that increased efficiency and reliability will bring about lower paving and maintenance costs that will be reflected in greater profits for the contractor and an ever increasing road building program to the benefit of those who use our highways.

Each year brings examples of these improved or entirely new and unprecedented machines to the Annual Good Roads Show, to the end that contractors and engineers may see them and judge their merits under conditions of easy comparison with competing equipment.

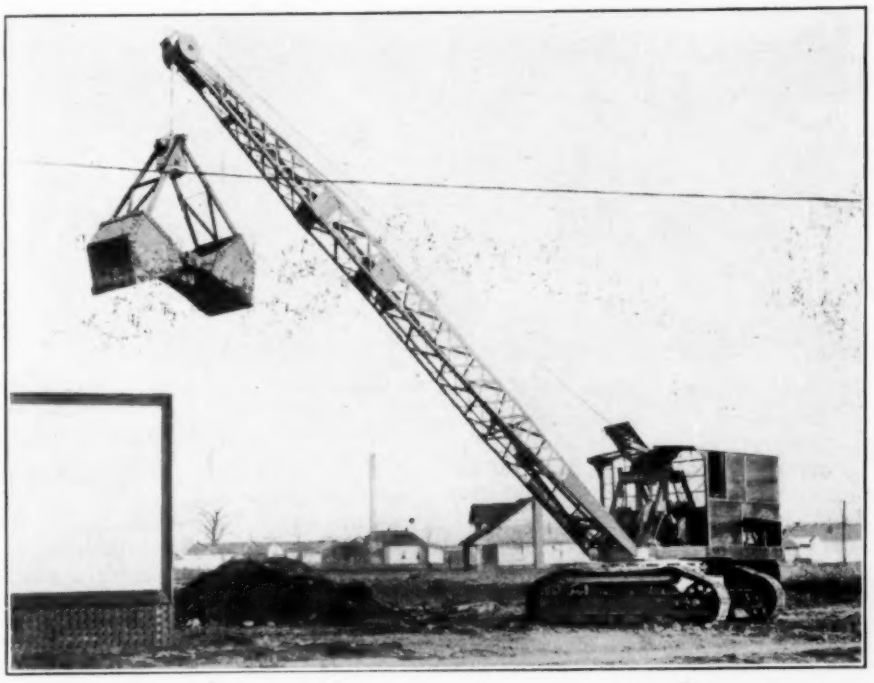
Each year, then, brings to us the opportunity to review this progress in equipment design, to the end that those who attend the road show may find their own investigations of these machines a simple matter, and to the end that those who are unable to attend may at least know something of what the manufacturers have prepared for their use during the coming year.

While the following descriptions are representative of the developments to be announced and demonstrated at the show, they do not include the many excellent things there shown that are already common tools in the trade and known to the contractor through being shown at previous road shows and through use in the field, nor do they include possible other new developments of which the details have not yet been disclosed by the manufacturers. There yet may be some interesting surprises in store, and a visit to the various booths will be needed to learn about them.

Available information, however, enables this journal to announce to its readers the following interesting equipment that is either brand new, or that has been improved in some marked degree during the past twelve months.

Osgood Company to Show Improved Shovel

The Osgood Company, of Marion, Ohio, will exhibit an Osgood 1¼ yd. heavy duty gasoline shovel that reveals many refinements and represents the latest efforts of their designing engineers. An adequate sales staff will be on hand to explain these improvements and expound the merits of the other products of this concern. No details of the new improvements on this shovel were available at the time of going to press.



New Orton Model "G" 10-Ton Crane With Orton One-Yard Clamshell Bucket to Be Exhibited at Road Show, Readily Convertible to Shovel on Other Equipment

Orton to Exhibit New Models at Road Show

The Orton Crane & Shovel Co., Chicago, recently has brought out three new models of cranes, all of which are convertible into shovels, draglines, ditchers and skimmers by changing the booms.

The Model "A" crane has a capacity of six tons, and can handle a ½-yd. bucket with a 30-ft. boom; as a shovel it has a capacity of ½ yd. This model is exceptionally economical for small excavating jobs.

The Model "G" is rated at 10 tons, or 1 yd., and is adapted for excavating and contract work. It has sufficient capacity for serving a 27E paver and, like the Model "A," can be shipped without dismantling.

The Model "W" is rated at 12 tons, or 1¼ yd., and is adapted for jobs where a large amount of material must be handled quickly and economically.

Ratings are conservative, because all working parts are made with a liberal factor of safety. Crane booms are of the four-angle, lattice, box-section type, giving strength and rigidity without excessive weight.

All of these models are arranged for operation by gasoline engines or electric motors. They are equipped with the Orton flexible (spring type) crawling tread, are full-revolving, and have separate clutch shafts for traveling, steering, swinging, hoisting, crowding and booming so that operations can be performed independently and simultaneously. Roomy, all-steel cabs are provided, with the operator's position well up in front to give a clear view of the work.

A Model "A" ½-yd. shovel and a Model "G" 10-ton crane with 40-ft. boom and 1-yd. Orton clamshell bucket will be exhibited at the Road Show.

Thew Shows New Control Features on Back Digger

The Thew Shovel Company, Lorain, Ohio, will show a new back digger, or trench hoe, attachment for their Lorain 75 shovel. An unusual feature of this back digger is the controlled dipper which can be tilted to any angle for the best digging and dumping efficiency. This dipper is controlled by the operator in the cab at will.

The Lorain 75 Shovel Equipped with New Back Digger Attachment Working on an Excavating Job and Loading Dirt into Motor Truck. This Loading Is Under Accurate Control Due to the Tilting Dipper Principle Incorporated in the New Design

For the first time, say these manufacturers, it is now possible to control the dipper load with a back digger so that it can be dumped accurately into a motor truck, or exactly where wanted on the spoil bank, due to the tilting dipper principle. One of these machines is illustrated, dumping a load into a dump truck.

Williams Shows "Double-Arch" Dragline Bucket

The G. H. Williams Company, Erie, Pa., will show a new Dragline Bucket that has a rigid "Double-Arch" to overcome one of the most stubborn obstacles to successful dragline bucket operation.

The tendency of dragline buckets to pull in at the sides, in hard digging, has been entirely overcome by the development of the Williams "Double-Arch." A heavy one-piece steel bridge across the top is reinforced by a heavy alloy steel digging lip. An arch above, and one below, takes care of all pulling-in strains, and holds the shape of the bucket even after the hardest continuous digging.

To make this bucket even stronger, the scoop of this Williams Dragline is rolled from a heavy one-piece steel plate which forms both the bottom and sides, with the back flanged in and securely riveted.

This rigid one-piece scoop is reinforced on the bottom by heavy flat bars, which also serve as runners. The bars extend the full length of the bottom of the bucket. Standard digging teeth, with reversible manganese steel tips, are riveted to these bars.

It can be adjusted quickly for shallow stripping cuts, for sloping ditches, or deep digging—on each class of work, giving the full advantage of the bucket's entire weight, and doing away with "skidding" when the drag chain is overhauled, according to the manufacturers.

The dumping chains have been fully protected against fouling, and the trunnions have the closed side toward the work, so that they can't clog up with material. There is no obstruction to catch and build up material—assuring a fast clean dump every time.

While the line of Williams Clamshell Buckets is of course well known, it will be worth while seeing the latest improvements in the Williams Clamshell line, and the working model which will be operated at the Road Show.

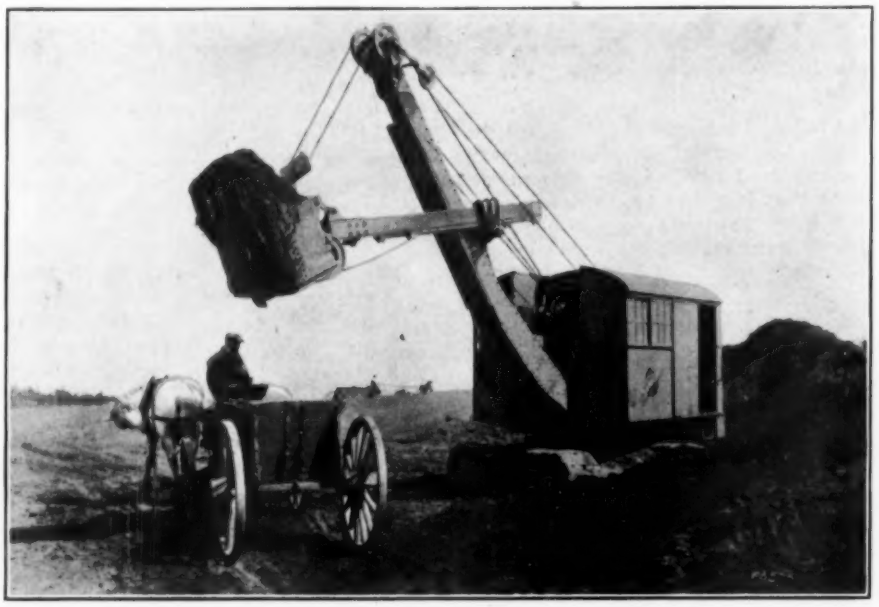
For instance the new heavy steel plate head, of improved design—with a very short head bearing of extra large diameter. The heavy forged steel corner bars are held together in a rigid "A-fame" that takes the strains of digging, opening and closing.

The plate head construction, lighter than a cast head, gives the bucket ideal balance for fast operation, while giving a big margin of surplus strength.

Williams "Double Arch" Dragline Bucket

Moore Speedcrane Shows New Shovel

The Moore Speedcrane Co. of Chicago will display a new 1¼-yd. shovel that has a newly developed crowding action that is said to be quite an improvement. This machine has been entirely redesigned and developed into what is said to be the simplest, the strongest, and the most powerful gas shovel now on the market of that size. It is also said to be able to do more work than any other shovel of the same rating. This capacity for work is said to be obtained without the usual excess weight.



The New Moore Gas Shovel With the Unusual Crowding Action

The New Bay City Trench Scoop Powered with McCormick-Deering Tractor and Equipped with Full Crawler Mounting

Bay City Has New Trencher

Another new trencher outfit is being displayed by the Bay City Dredge Works, of Bay City, Michigan. This is a new adaptation of the Bay City Tractor Shovel that was displayed last year for the first time. This machine derives its power from an International Harvester Co. McCormick-Deering tractor, equipped with full crawler mounting. While the shovel weighs 9½ tons, and is equipped with shovel boom and ⅜ yd. shovel bucket, the tractor trencher is equipped with a trench boom and scoop. The same exhibit wil include a Model 16-B, ¾-yd. convertible excavator, weighing 20 tons and equipped with full crawler mounting, Climax gasoline engine, fully enclosed steel cab, and ¾ yd. skimmer bucket.

New Convertible Crane with Tractor Power

The Vergan-Schmidt Company, of Champaign, Illinois, is demonstrating a new Tractocrane outfit that is available for clamshell or magnet use, and that can be equipped with pile driver, power shovel, trench hoe, skimmer, and other attachments so as to do a wide range of work. Powered with a Fordson or McCormick-Deering tractor, this outfit may be equipped with full crawler or semi-crawler traction or with rubber tired wheels as desired. It may be furnished with 20 or 25 ft. boom, ⅓ or ½ yd. clamshell bucket, or equipped as a ⅓ yd. shovel or skimmer. It is made for a full half circle swing, and all attachments are interchangeable. Floating work may be done with the equipment, since attachments are available for attaching the equipment to a hull.

The unit weighs from 16,000 to 20,000 lb., depending upon the attachments used, the wheelbase is 137 in., and the width 8 ft. 6 in. The outfit has several travel speeds ranging from 1½ to 10 miles per hour, and will negotiate any ground. The turning radius is short. The lifting capacity ranges up to 4,000 lb., and this capacity may be doubled with the use of outriggers. Users are reported as claiming that operating costs, including interest, depreciation, and wages of operator, do not exceed $2.00 per hour, say the manufacturers.

Unloading a Car of Aggregates with the New Vergan-Schmidt Tractocrane. Shovel and Other Equipment Also Available

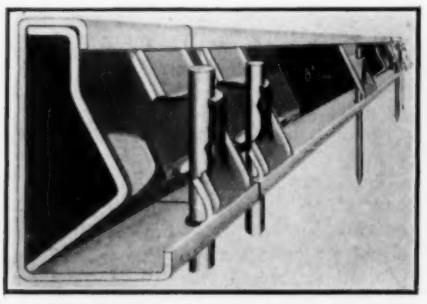
Heltzel Announces Stronger Road Form

In line with the current tendency to steadily increase the strength of road building equipment, the Heltzel Steel Form & Iron Company has produced a stronger and more rigid road form. It is shown in their booth. The design of the Heltzel road rail is unchanged. It is made of $\frac{3}{16}$ in. special steel plate with double reinforcing flanges and 6 in. base.

Massive steel stake pockets are welded to the two rail flanges. Giant 1 in. round steel stakes are used with an angular shaped steel joint lock of ¼ in. steel plate. This stake lock wedges between the stakes and the face of the rail with one leg of the lock wedging against the intersection of the face and top of the rail and the other leg wedged against the intersection of the face and base of the rail.

Two wedge shaped swells pressed into the stake lock wedge, one against each stake, making what is said to be an absolutely positive locking arrangement and a larger swell pressed into the stake lock serves as a releasing lug which, when tapped with a sledge, unlocks the form. Heltzel's joint locking arrangement not only locks the form but automatically aligns the rail ends and holds them so rigidly that deflection at the rail joint is impossible.

From a standpoint of setting or stripping the forms, these operations are evidently simple. The form is a complete unit with the stake lock in one end of the rail, there being no separate parts excepting the two stakes. To set the forms, simply butt the rails end to end, place the joint lock in position, and drive the stakes. One tap with the sledge locks the forms and aligns the rails.



The New Heltzel Road Form Is Very Rigid.

Universal Shows New Crane Developments

The Universal Crane Company exhibit at the 1928 Road Show will consist of two cranes, one showing the motor truck crawler attachment, the other a 52-ft. boom. Both these are new truck crane attachments of 1927 development by Universal engineers to meet the constantly increasing uses of truck cranes. It is the first time either of these attachments will be exhibited at the Road Show.

Universal 5-ton Motor Truck Crane With 52-ft. Boom

The Universal Crane Motor Truck Crawler is an attachment designed to readily fit on any 4-wheel Universal Crane motor truck mounting, giving a fully rubber tired 8-wheel motor truck. More than this, the group of 6 rear wheels (3 on each side) is so designed that in approximately 15 minutes a belt of cast steel crawler treads can be fastened over them, making the rear end a complete crawler. This crawler develops only approximately 10 to 12 lb. per square inch ground pressure, sufficient to traverse any kind of soft ground. The crawler unit is of the high speed type, propelled constantly at truck speeds. It possesses features of flexibility not found in the usual type crawler, which will be clearly demonstrated at this exhibit.

The 52-ft. boom is the longest standard boom built for truck crane use. It is made up of Universal standard 28-ft. boom with 8-ft. base and 16-ft. head extensions, both readily detachable to permit using shorter booms when more suitable.

Universal cranes are built in lifting capacities of 5, 6, 7½ and 10 tons. The units exhibited at the Road Show will be of 6 ton capacity. They will be exhibited in space AA-10 on the arena floor of the main Auditorium, right in front of the stage.

Relay Motors Corporation Shows New Trucks

The Relay Motors Corporation, Lima, O., will display the new Relay Model 30-A, 1½ ton truck chassis that has been particularly designed for the road builder. Here, for the first time, can be seen the Relay principle applied to a truck of this size. It features a speedy, sturdy, 6-cylinder, detachable, high compression type engine, battery, ignition, a new design of streamline radiator and hood, four-speed transmission, drop forged "I" beam front axle especially adapted to four wheel brakes, Relay drive rear axle which harnesses two hitherto uncontrolled forces—dead weight and momentum of load and chassis—turning these into supplementary power to that of the engine, 4-wheel hydraulic brakes, improved type steering gear, pneumatic tires front and dual pneumatic tires rear, and complete electrical equipment.

The same booth will contain Relay Model 70-A, 3½ ton chassis having an all-weather cab and LaPlante-Choate Snow Plow, a Garford Model 30, with a 1½ to 2 ton chassis with all-weather cab and a standard 1½ cu. yd. dump body and hoist, together with a working model of the equipment.

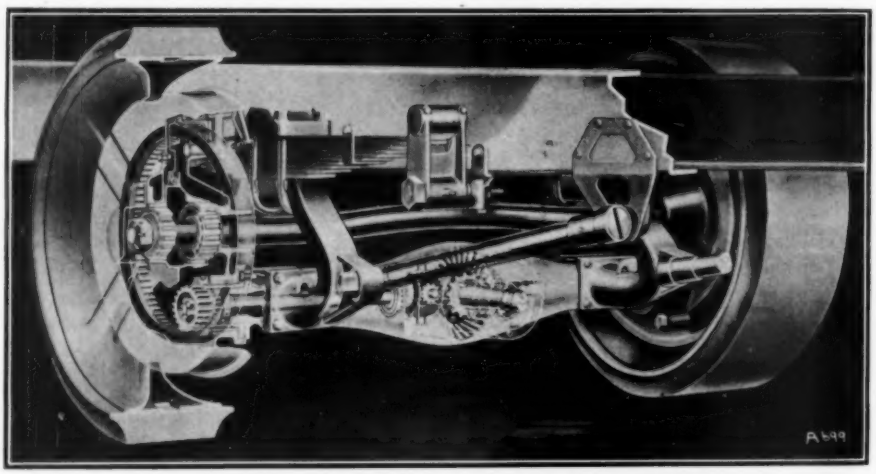
Riddell Shows New Snow Plow and Roller

The W. A. Riddell Company exhibit will feature the Road Hog grader and many other units of the H. P. line of road machinery.

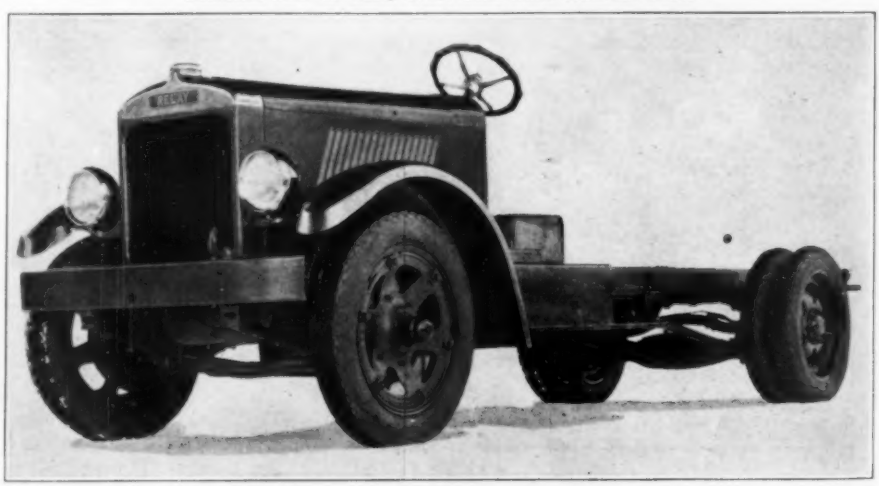
This line includes the E. F. and B. models of the H. P. one man graders, which will feature the head type steering gear, the independent scarifier, leaning wheel, side crank, easy seat, cab and other refinements.

An additional attraction will be the new Warco snow plow which is attachable to the H. P. Grader, making it an all year road machine, earning in winter snow removal as well as in building and maintaining roads the rest of the year. The plow is easily attached and is operated from the driver's position. It can be lowered using only the plow for light snow or when snow is heavy the blade of the grader takes care of the lower snow while the raised plow handles the top snow, making it possible to remove deeper snow than with either implement used separately, according to the manufacturers. The plow is not expensive and is economical, requiring only the one man for its operation.

Another feature of the Warco exhibit



Phantom View of Relay Drive Rear Axle With Its Parts



Chassis of One of the New Relay Trucks

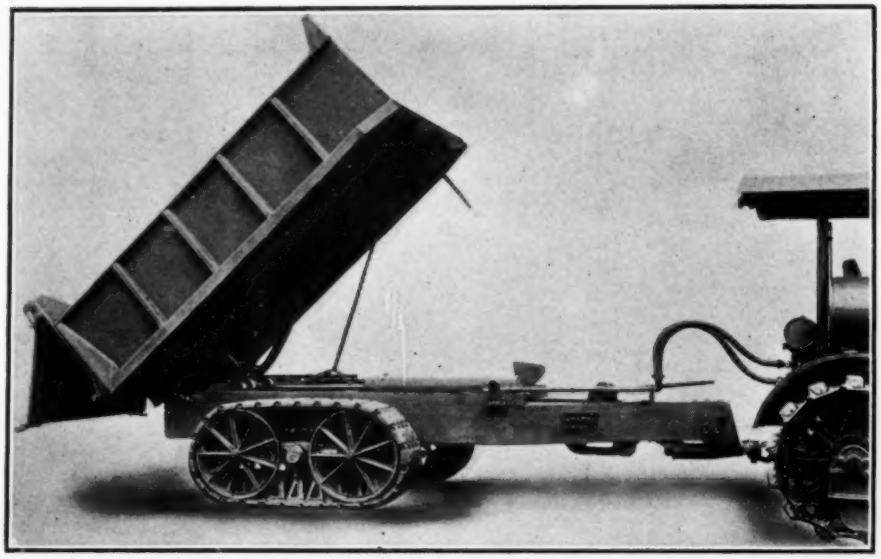
will be the new H. P. Road Roller which is built in 5 to 10 ton sizes. The roller is impressive in appearance and capable in action. It combines many good features in roller construction and limits the power cost to the economical tractors of which it is a part.

The well known crawlerizers of the H. P. line will be on exhibition. There will be the Alwaytracs, the Rigid Rail Tracks and the Cahl Tracks, all superior for their various purposes and all capable of moving loads beyond the power of wheel equipment.

New Buckeye Service Ditcher

Another interesting new trenching machine, based upon a different principle, is shown by the Buckeye Traction Ditcher Company, of Findlay, Ohio. This new Model 150 service ditcher is of the chain and bucket type, and is a small, light weight machine that has been designed for unusual flexibility of performance. It is designed for cutting widths up to 26 in. and for cutting depths up to 8 ft. It is mounted on two full-length crawler type traction units designed to give a bearing pressure of 7 lb. per sq. in. Unique drive sprockets are featured. Adjustment and lubrication are simple.

Steering is done by two twin disc friction clutches, and is said to be easily controlled to line. Change of digging speed is made possible by a lever at the operator's platform. Buckets are of electric cast steel, annealed and self cleaning. Changing of bucket sizes involves but little work. A safety sprocket is provided at the end of the excavator shaft to provide a release under overload. The trencher is powered with a heavy duty tractor type motor developing 52 b.h.p. at 900 r.p.m., mounted with transmission and clutch on a rigid cast base to prevent it getting out of line. The trencher can dig when traveling both backward and forward, digs straight down, and is equipped with a crowding mechanism that keeps it up to the work.



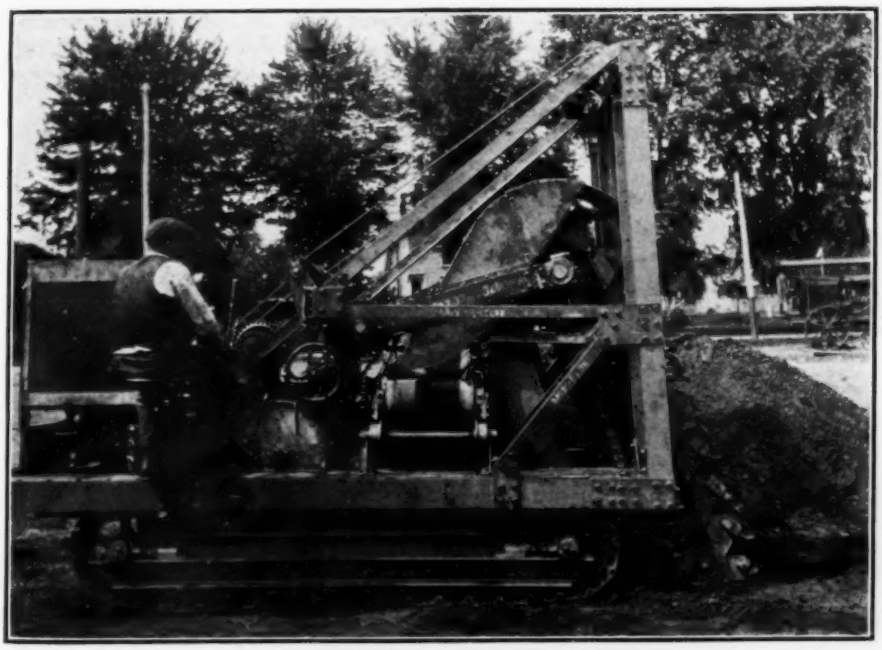
A View of the New Athey Equipment With The Body in Dumping Position. It works on Ground That Would Stall Wheeled Equipment

Athey Truss Wheel Exhibit of Interest

Heavy hauling equipment of interest to the contractor whose dirt moving jobs call for great yardages per day, is shown by the Athey Truss Wheel Co., of Chicago, Ill.

The equipment on display at this booth is new, a combination of the Gar-Wood Hydraulic Hoist and the standard Athey Chassis, coupled direct to a Caterpillar tractor. It is made in three sizes; the 4-5 yard, the 6-7 yard, and the 7-8 yard. The smaller size is made exclusively for the Caterpillar "Thirty," while the second size can be used with either the "Thirty" or "Sixty," and the largest size requires the "Sixty," as does the 6-7 yard machine under adverse conditions. The first two sizes are equipped with ten ton Athey Truss Wheels, while the larger size is equipped with fifteen ton Athey wheels.

A number of these outfits are already working in the field and indicate that their chief advantages are that they can work in wet weather as well as in dry and that they can be worked in two shifts where animal equipment can only be worked one shift, according to the manufacturers.

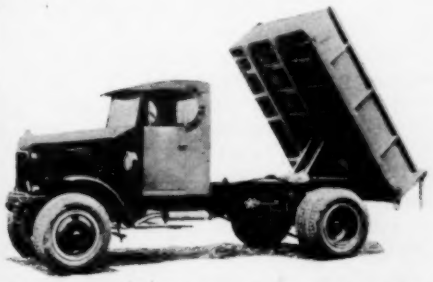


New Buckeye Service Ditcher Shown at the Buckeye Booth.

Heil Hoist Gives High Dumping Angle

The main point that will be noticed at the Heil Company booth is the method of installing the improved Hydraulic Hoist that now gives a dumping angle 57 degrees, thereby affording a quicker and cleaner dumping action, speeding up the work.

Other equally interesting innovations are shown.



Heil Body, Model 11, and Hydraulic Hoist Mounted on an International Harvester Model 54C Truck So as to Give a Dumping Angle of 57 Degrees.

The Hug Ready Mixed Concrete Body Mounted on Hug Road Builder Chassis, Dumping Wet Batch into Receiving Hopper

Special Truck Body for Central Mixing Plants

A feature of the Hug Company exhibit this year is the new Hug ready mixed concrete rear bottom dump remixing body designed for use in delivering concrete from a central mixing plant. Twenty of these were recently shipped to the Cleveland Trinidad Paving Company, of Cleveland, mounted on Model 88 Hug road builder chassis. This body was designed for the express purpose of facilitating the handling of wet concrete and hauling it from central mixing plants. The outstanding features of the body are that it is a rear bottom dump and the wet batch is remixed as it leaves the body. The entire operation of the body is controlled from the drivers' seat, everything is automatic, and as the hydraulic hoist raises the body, the upper shell of the body is elevated by toggle arms, thereby separating the shell from the bottom part or bed. The body is equipped with rigid cross members, and as the body is raised, the wet batch is remixed while falling through these rigid cross members. Due to the bottom dump feature the body clears itself of all the wet batch material. The same company will display three models of their road builder truck as well.

The Linn Tractor a New Form of Truck

The Republic Truck Sales Corporation, Alma, Mich., the selling organization for the Republic Motor Truck Company and for the Linn Manufacturing Corporation, of Morris, N. Y., a division of the Republic Motor Truck Company, will show the Linn tractor. This is actually a heavy duty dump truck that has crawler treads instead of rear wheels. While other bodies are supplied as required, the tractor here illustrated is fitted with a 5 yd. dump body. The main feature of the Linn tractor is that it is a motor truck, operated as such, and yet it has the mobility and power of a tractor, operating on ground that would stall a truck. Both six and four cylinder models are available. The same concern manufactures a snow plow for mounting on this tractor, providing in this way a heavy duty snow removal outfit that is said to be very effective. The tractor in design, construction, and equipment, follows current heavy duty truck practice. The track is designed for a loading of 17 lb. per sq. in. on the road surface when a 5 ton load is being hauled. On first speed of 1½ miles per hour, a drawbar pull of 15,000 lb. is exerted, while on the fourth speed of 8½ miles per hour the drawbar pull is said to be 3,000 lb. This six-cylinder tractor is rated at 100 h.p., while the four cylinder model is rated at 75 h.p. Both are powered with the Waukesha motor.

The Linn Tractor Truck to Be Shown in the Republic Booth

Williams Shows New Crusher for Wet Rock

The crushing of wet muddy rock without choking the crusher has become an increasingly important subject in the last few years, especially in quarries where overburden or mud must be handled with the rock. As evidenced by the several types heretofore offered by the Williams Patent Crusher & Pulverizer Co. of St. Louis, this company has given considerable attention to the subject, and in addition to the Tractor Feed and Roller Breaker Plate Hammer Mills, Williams now offers a new type, the Pusher Feeder.

Actual crushing is accomplished by the well known Williams Hinged Hammer Principle, the fast revolving heavy duty hammers reducing the material by impact. However, the distinguishing features are, a pusher feeder which forces the material into the path of the hammers and a vibrating arrangement for keeping the grate openings clear at all times.

Choking when it does occur in a hammer crusher is generally due to material adhering to the breaker plate and accumulating there until the feed opening is greatly reduced in size or entirely closed. All such difficulties are

overcome when the pusher feeder is employed as two flat reciprocating piston like rams work up and down on the breaker plate and scrape it clean on each stroke, forcing the material into the path of the hammers.

The vibrating grate mechanism is also an important improvement in keeping the grate openings free of material. It is actuated by a crank shaft extending across the front of the crusher and which rocks the grate bars back and forth like the ash dumping grates of a furnace fire box. As the openings always remain uniform, there is no possibility of oversize rock passing through into the finished product. The grate bars are also provided with an adjustment which permits them to be raised toward the hammers to overcome wear.

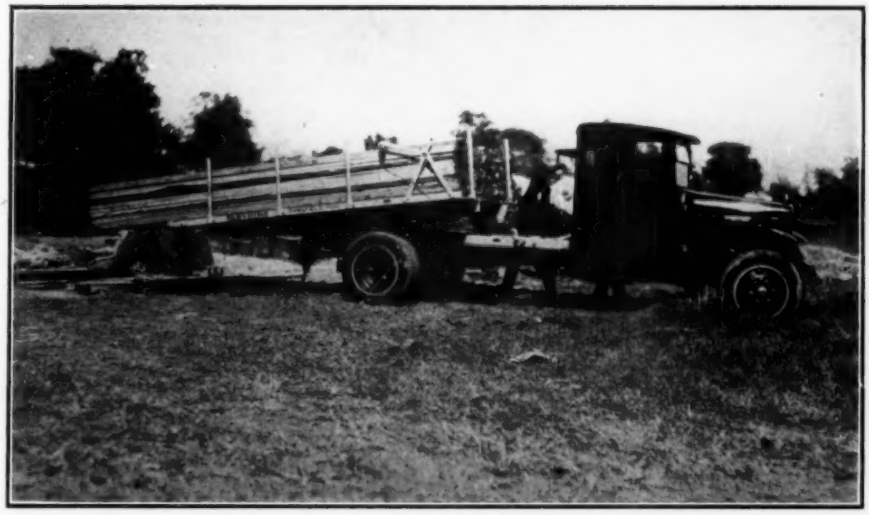
All "Non-Clog" mechanism is driven from the main crusher shaft and no auxiliary drive is required. Only two gears are used and these are so placed and protected as to positively prevent entry of dirt and grit. All sizes of Williams Hammer Crushers can now be furnished with the new Pusher Feeder and vibrating grates.

Automatically Unloads Lumber or Other Material

A new body has been added to the line manufactured by the Hughes-Keenan Company. This equipment, known as the Lumberjack, is to be seen in the booth of that company.

The Lumberjack is intended to speed up the unloading of such materials as lumber, tile, brick and other building materials. It is a simple and adaptable piece of equipment suited to trucks of any make or size.

In operation, the load, lumber for instance, is placed on the platform body as usual and held in place by special locking device. When ready to unload, entire platform body is rolled back until rear end of load drops easily and smoothly to the ground. As the truck moves away, the load rolls gently off the body on rollers in the body itself and is deposited in a neat pile without being touched by the driver.

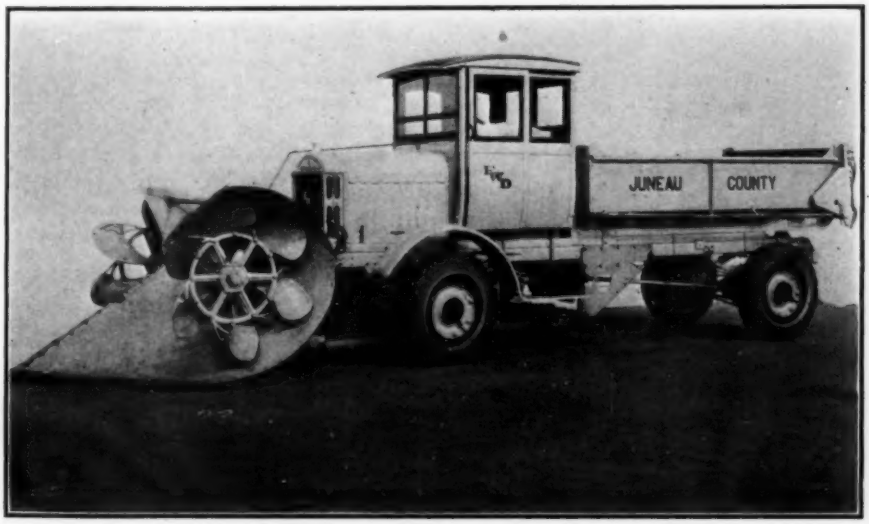


Hughes-Keenan Lumberjack About to Dump Load of Lumber

With loose materials such as brick and tile the operation is the same except that planks are laid on the platform body first and the load piled on them. The planks are deposited on the ground under the stack just as you would pile if doing it by hand.

The body frame is steel with a wood bed. While driving, the body does not rest on the rollers. An especially designed adjustable jack supports the rear end of the truck when unloading, and relieves it from strain.

This new device will be very welcome to the contractor and building supplier who wants to increase his truck's usefulness. Unloading time per load can be cut from 5 to 45 minutes—a big saving in the course of a day.



Rotary Snow Plow on FWD Commercial Utility Truck

Rotary Snow Plow on FWD Truck

The FWD Commercial Utility truck will be shown in the FWD booth, equipped with a Snow King snow plow. It is unnecessary to constantly raise or lower the plow in varying depths of snow as the FWD truck has plenty of power to remove the snow regardless of depth. The only adjustment is when driving over bare stretches or when covering is to be left on the road surface. The plow is raised and carried on two caster rollers mounted on roller bearings within a sliding shoe. Raising and lowering is done by screws at the rear and front center of the plow. The rotors can be operated separately, thus widening the roads by driving up close to the banks on either side of the road, throwing the snow from 10 to 40 ft. from the road.

The speed depends upon the amount of snow and its condition. In moderate depths of loose, dry snow, the highest speed can be employed. As the depth increases and the snow becomes heavier the lower speeds of the FWD are used, while in extremely deep drifts progress may be reduced to very short distances at a time. The FWD loses no time traveling from one drift to another.

The rotors, mounted on heavy seamless tubings, revolve on two large tapered roller bearings. The fan blades are of the "bird wing" shape. They are braced and supported at 4 points, making the entire assembly as rigid as though made of one piece. The material is 10 gauge unannealed low carbon steel. It is tough and strong. The rotors are protected against damage by a "shear pin" type drive flange. Upon striking an immovable object the shear pin will give and so confine the damage to perhaps one or two fan blades. These can oftentimes be bent back into proper shape or, if necessary,

The Model 51-A Two Batch Dump Truck Designed for the Paving Contractor by the White Company

replaced. The snow is scattered in a fan-shaped stream and is evenly distributed.

Successful operation is due largely to the hitch by which the plow is attached to the FWD trucks. The plow oscillates independent of the trucks so that the latter carries none of the weight of the plow. Being close coupled, the entire unit is easily handled as the FWD trucks have traction on all four wheels and have a very little tendency to slue or slip.

The power to drive the rotors is taken directly from the FWD motor crank case by means of a connecting shaft and universal joints. The plow is pushed, ahead of the truck, being so attached as to make use of the full traction the four wheel drive truck offers.

Complete adjustment is provided to properly set the plow for loose or frozen snow. Detachment can be made in a moment by removing 4 pins. No hitch parts need be removed to make the truck available for other service.

As the mold boards break up the snow and force it into the rotors the latter expel it and so relieve the pressure. The snow does not have to be lifted, making a further saving of power. The rotor plow does not require a separate motor and can be successfully operated by the motor of the FWD truck.

White to Exhibit Three Dump Trucks

The White Company booth will contain three 1928 model dump trucks. The first of these is Model 52, a heavy duty dump truck chaissis with auxiliary transmission, combining a power tower for operating the dumping mechanism with an extra low gear for operation in soft ground and in excavations where heavy loads and steep grades are combined with severe road conditions. This auxiliary low gear permits a lower numerical axle ratio, making for higher road speed and faster operation. The second is Model 51-A, a 2½ ton two-batch dump truck, with short wheelbase especially adapted to road building work, and equipped with a body handling two batches for a 27-E paver. The high road speed and rugged construction fit it well for this work. The third truck will be a model 15-B, a one-ton dump truck with hydraulic underbody hoist, designed for road maintenance work where a fast, small capacity, dump truck is needed. A further exhibit will be prepared at the factory, and inspection trips to the plant will be facilitated.

Wehr Mounts Anthony Body on Grader

In cooperation with the Wehr Company, the Anthony Body Company of Streator, Illinois, has designed and built appliances for adapting the standard Anthony dump bodies to the Wehr grader.

A number of these dump body equipped Wehr one man power graders are now in use by road patrol men who carry with them gravel for patch work, special equipment and tools for road crews, etc.

The bodies may be mounted on any model of Wehr grader, whether equipped with rubber tired wheels or crawlers.

This type of installation will be shown for the first time in the Wehr Company booth this year.

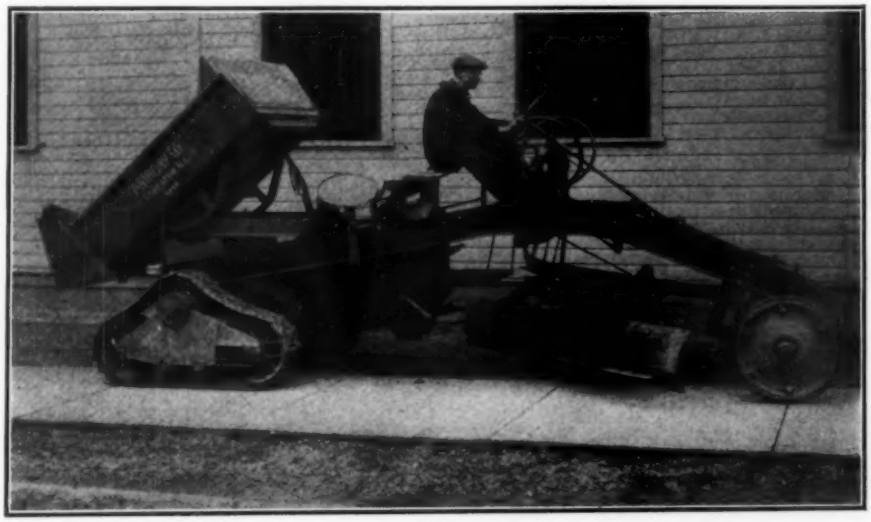
New Novo Rollr Engines for 1928 at Show

A new single, a new two, and two new fours, will be added to the line of Novo Rollr industrial engines in 1928, and displayed at the Road Show.

At present, there are three sizes of two cylinder Novo Rollr Engines: 6, 9 and 12 hp. These are available in either hopper or radiator cooled types. The first engine of this series, the 6 hp., was brought out January, 1926. Later, the 9 and 12 hp. engines were offered, augmenting the line. The success of these new Novo Rollr Engines in 1927 has proved that the trend is definitely toward more flexible and up-to-date power units. The demand is for more power on practically all equipment. Novo Rollr Engines give this extra power without adding weight.

A Novo two-cylinder Rollr Engine of another size will be offered in January. This will be an 8 hp. unit, being designated as Model HU. It has a $3\frac{7}{16}$-in. bore and 4-in. stroke, and will be similar to the 6 hp. FU engine. The line of two-cylinder Novo Rollr Engine will then include machines of 36, 10 and 12 hp.

These engines are available in both radiator and hopper-cooled types. Steel housing is standard equipment on radi-



One of the Anthony Dump Bodies Mounted on a Wehr Grader, as Demonstrated at Show

ator-cooled types, and is offered as an extra on hopper-cooled engines.

The two new single cylinder Novo Rollr Engines will be, in appearance, similar to the well known line of two-cylinder engines. Obviously, they will be smaller, i. e., the cylinder block will be shorter than the two-cylinder Rollr engines. At present, it is planned to manufacture two sizes, 3 and 4 hp.

The salient features of single cylinder Novo Rollr Engines will be the crankshaft running in Timken roller bearings, the counterbalanced crankshaft that reduces vibration to new low limits, easy and safe starting, the high tension magneto that gives a hot spark at any cranking speed, positive lubrication, the compactness of the equipment, and the right-hand cranking feature.

At the same time, Novo will also bring out two new four-cylinder engines. These will also be known as Rollr engines, since in construction details they closely resemble the well known line of two-cylinder Rollr engines. In fact, they are "doubled-up" two's, in 12 and 16 hp.

These new Rollr engines incorporated advanced practices, such as are found in no other four-cylinder power units. At the same time these developments are practical, since they have been in general use on all Novo two-cylinder Rollr engines for two years. Briefly, the features of these new engines will be similar to those of the two-cylinder engines.

Novo Rollr engines are so flexible and smooth in operation that they are suitable for running practically all types of equipment within their horsepower range. As an example of the variety of work done, Novo two-cylinder Rollr engines are used to operate ice cutting machines, saw rigs, paint sprayers, concrete and plaster mixers, road finishers, generators, blowers, pumps, hoists, conveyors, track unloaders, air compressors, vacuum cleaners, asphalt repair plants, road graders, and dirt pulverizers.

Adams Announces New Motor Grader

J. D. Adams & Company of Indianapolis, will show the new Adams Motor Grader No. 10, for the first time at the Road Show. This new grader is said to be an outstanding engineering achievement, the result of several years of painstaking development.

The Adams Motor Grader is used with McCormick 10-20 Tractor and embodies several new features in design and construction. An entirely new type of blade control makes it possible to raise the blade 50 per cent faster than with the ordinary type and with half the energy, say the manufacturers. This is made possible by a continuous handwheel motion and by a leverage, given through reduction gears, that is twice that of ordinary hand wheels.

One of the noteworthy features of Adams Motor Grader No. 10 is the exceptional strength and rigidity of construction throughout the machine which gives it a smooth, steady cutting quality. The frame itself is made of 10-in. channel steel and employs a new and distinctive method of bracing or stiffening with four large tubular steel cross members—an exclusive construction that absolutely prevents frame twisting or weaving.

Lost motion through the machine has been entirely eliminated. All gears—blade lift, scarifier, control and steering—are machine cut to a perfect fit, are closely housed and run in oil. The worms of all controls are fitted with adjustable end thrust bearings—an exclusive Adams feature that makes it possible to eliminate all lost motion in the gears and hand wheels. The lift arms are drop forged steel and machined at the bearing points.

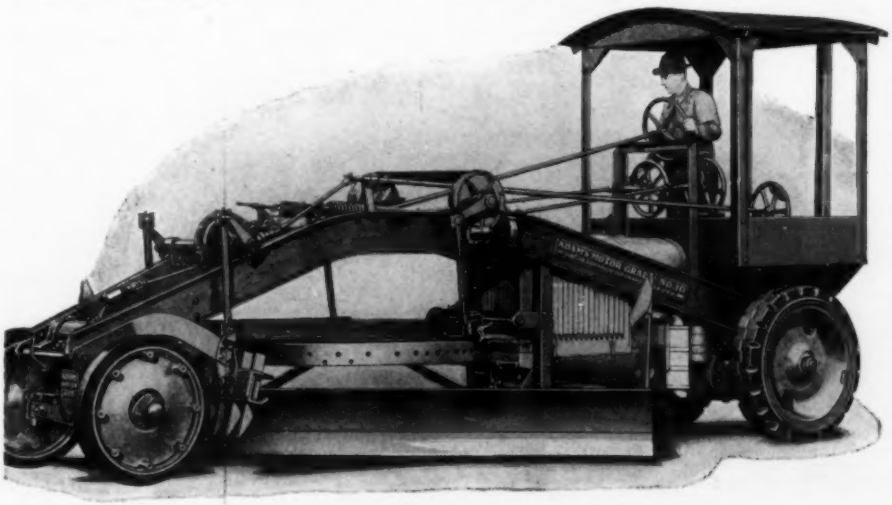
Another factor contributing to rigidity of construction is the fact that ball and socket joints are used throughout the blade and scarifier control including the lift link and moldboard connections. A three-point locking of the semi-circle to the reversing circle is another step taken to eliminate any wobble in the circle and the resultant chatter in the blade.

Other features of construction include an extra large semi-circle that gives exceptional support to the blade and is said to be the largest of any grader of similar size; a wide, strongly riveted drawbar; and and all-riveted construction throughout the machine, eliminating bolts wherever possible; and an unusually heavy and strong front end.

The tractor motor is easily accessible and is suspended in a stirrup of all-riveted construction, thus avoiding the ordinary motor vibration which comes with bolted construction and which leads to blade chatter. A special cranking device permits cranking from either side.

The blade of the Adams Motor Grader has a clearance of 16 in., greater than that of any grader of like size. It has a side-shift of 25½ in., easily made through a control from the operator's platform. The grader is equipped with 10, 12 or 16 ft. blades. The wheelbase is 16 ft. 10 in. The front whels are 32 in. with 5 in. tires and the rear wheels are 40 in. with 10 in. or 14 in. single tread tires.

A strong scarifier attachment is provided on order. It is raised and lowered independently of the blade by one set of enclosed gears like that used for the blade control. The machine is furnished with or without cab and curtains. The weight of the machine, complete with cab and scarifier is 13,140 lb.



The New Adams Motor Grader No. 10 Seen at the Road Show.

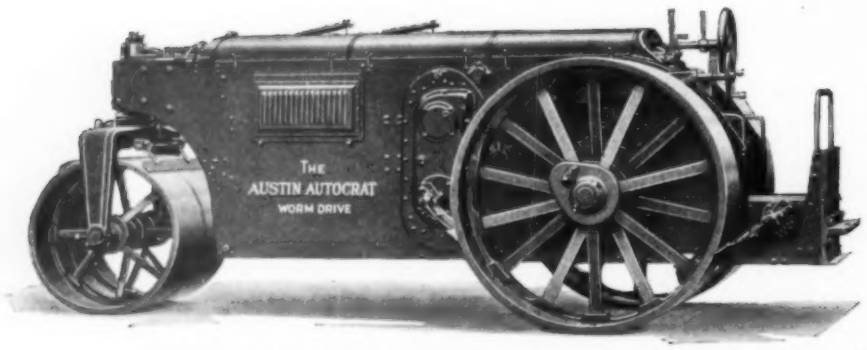
Ditwiler Shows New Hoist

Recognizing the need for a scientifically designed mechanical power-driven dump body, built on sound and new engineering principles, the Ditwiler Mfg. Co., of Galion, O., builders of Ditwiler Saftee steel dump bodies, will introduce an under-body mechanical power-driven hoist at the Cleveland Road Show.

Spending months on the design of this addition to their line and subjecting the new dump body to strenuous tests in the experimental stage, the new product has met the rigid specifications set by the company's engineers.

This power hoist dump body should prove of interest. Speed and stamina will characterize this new dump body, which will be of the same high standard of performance and efficiency as the well known Ditwiler Saftee Automatic and Hand Hoist jobs, which will also be shown at Cleveland, according to the manufacturers.

The Ditwiler Saftee automatic body is dumped and returned by a lever from the driver's seat. Mounted properly for correct load distribution the body dumps without racking the chassis. This type is widely used in road building, espe-



The Austin Autocrat, a New Motor Roller with Worm Drive

cially in fleet operations. It is particularly efficient in working with a power shovel in the removal of earth from grades and excavations.

The Ditwiler Saftee hand hoist type is dumped and returned by means of a side wheel which is said to be absolutely safe to operate, as it locks in any position, is self locking and eliminates the use of a crank, which may slip and kick back with disastrous results to the operator. This model is recommended for use in road building, general construction work and delivering coal, etc. Side boards are available for increasing capacity and partition gates are furnished for making two or three batch bodies. With removable sides the hand hoist body is particularly adapted to handling brick, building supplies, tile and the like.

The Ditwiler people have recently entered upon production in their new plant, with the most modern machinery and equipment and the best of manufacturing facilities. A cordial invitation is extended to those attending the road show to run down to Galion—80 miles south of Cleveland on the New York Central—and visit the company's new home.

Austin-Western to Show New Roller

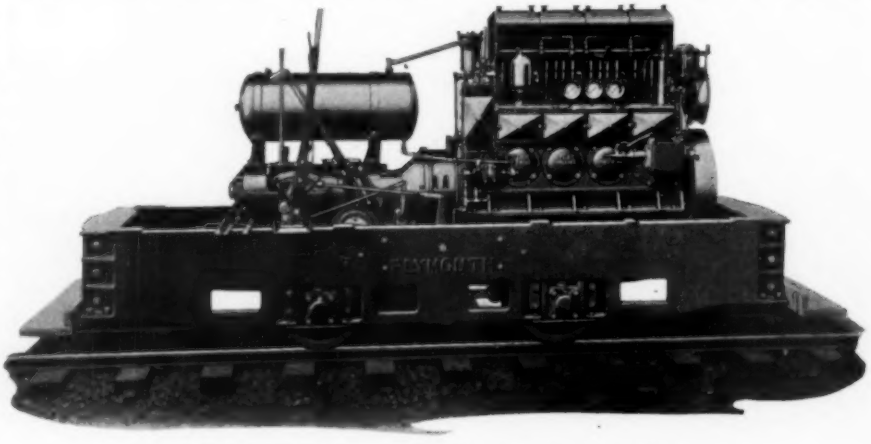
New equipment to be seen in the Austin-Western Road Machinery Co. booth will include the new Austin Autocrat roller, a worm drive motor roller of 10 tons weight, the Western Hot Patch outfit, and the Athey truss wheel dump wagon trailer. The Austin Autocrat's important feature is its worm drive. This type of drive is said to have decided advantages over other types of drive, such as a greater efficiency in the transmission of power, a greater immediate speed reduction, general reliability, lessened repairs, silent operation, and lessened vibration. A single worm and two worm gears one above and one below the worm, give a primary drive that affords equal efficiency when working either in forward or reverse. A combined splash and forced feed lubrication system is used in this drive unit. Clutches are of the twin-disc type, requiring but little adjustment. Adjustments are made easily without tools. A two speed transmission is supplied as standard equipment, while a three-speed transmission may be supplied on special order. The frame is of two heavy boiler plates, fabricated to give a pleasing streamline appearance, with hatches that give access to the motor. Ground clearance is ample, yet center of gravity is low. The motor is a heavy duty Buda, B.T.U., with 5 in. bore and 6½ in. stroke, giving 55 brake horse power at 1,000 r.p.m., and having a range of speed on the governor of 750 to 1,000 r.p.m., regulated from the control panel. A standard carburetor, together with an air cleaner, is regular equipment, while a high tension magneto with impulse starter provides the ignition. An effective sprinkling system and pneumatic scarifier are available when desired.

Plymouth Has New Diesel Locomotives

Speaking of batch boxes and industrial haulage reminds us that the Fate-Root-Heath Company, of Plymouth, Ohio, will show their new 10 ton and 12 ton diesel locomotives. The 10 ton locomotive and the 12 ton locomotive have been announced as quite the same, with the main difference that of weight. Larger sizes will soon be produced. The main reason for their adopting this type of power is that of fuel saving, making for cheaper power than is possible with gasoline motors. The power plant of the 10 ton size is a 4 cylinder, 4 cycle, enclosed type Atlas-Imperial Full Diesel engine, 6½ by 8½ in., developing 77 h.p. at 650 r.p.m. Starting is accomplished with compressed air, and a small combined gas engine and compressor is fitted in the cab for providing starting air, used for emergency only. The engine has a built-in air compressor that normally supplies sufficient air in the starting tanks.

The transmission follows the standard practice of the manufacturer, with sliding change gears that give four speeds forward and four reverse. A Twindisc clutch is mounted on the front end of the transmission, driven from a driving disc mounted on the engine crankshaft. The final drive from transmission to driving axles is by means of two short hardened steel roller chains. The engine, transmission, cab, etc., are mounted on a heavy cast-steel frame. The side frame members also form the truck frame, with provision for the roller bearing axle boxes. Cooling is provided by a Modine sectional radiator and a 30 in. bladed fan, driven from the engine. While hand brakes are standard equipment, air brakes may be installed.

The weight of the 10-ton locomotive is 20,000 lb. The drawbar pull is 5,000 lb. on dry rails at 2½ miles per hour. Additional speeds of 4, 8¼ and 13½ miles per hour are provided. The fuel tank holds 50 gal. of oil, lasting for 16 hours of operation, representing an approximate fuel cost of 10 ct. per hour.



Partly Assembled View of New Plymouth Diesel Locomotive

Root Spring Brings Out New Scraper

The Root Spring Scraper Co. years ago placed the first scraper under a motor truck. This method of gravel and earth road maintenance is now employed in many states with successful results. Several years ago the

Root Spring Scraper Co. placed on the market the first truck scraper that could be reversed, enabling an operator to cut from either side of the truck, just the same as an ordinary grader. These scrapers, and others which have made their appearance on the market, were all hand-operated, being satisfactory to a certain degree, but lacking the features which make a scraper 100 per cent efficient as a maintainer.

The objections to a hand-operated scraper, according to this manufacturer, are as follows:

1.—Very difficult to attach to a truck, on account of necessary raising and lowering device built in cab. There are trucks on the market, to which these scrapers could not even be applied.

2.—Difficulty in applying scraper to road with enough pressure to cut out chatter bumps and to really level road.

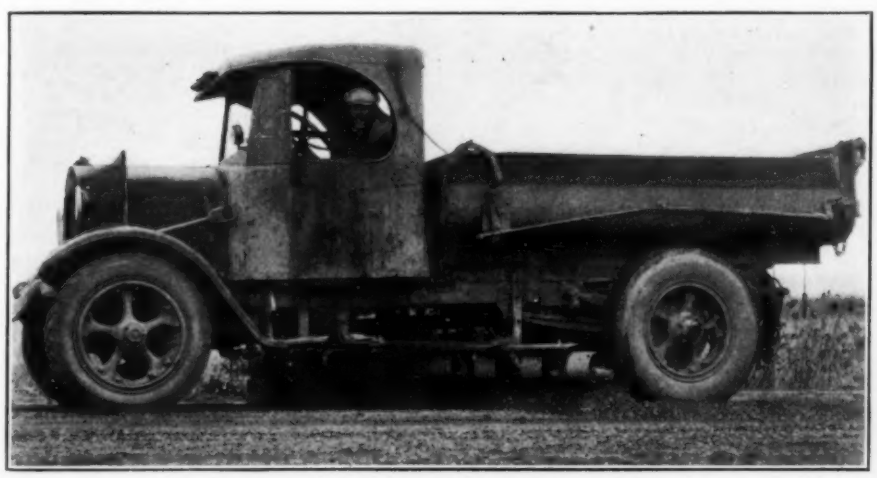
3.—Operation of scraper being through worm gears, it was very slow acting. This made the scraper unsatisfactory in working a road that necessitated the raising of blade in soft spots, etc.

4.—Often the operator scraped without sufficient pressure on blade, doing only a fraction of the cutting necessary.

Now this firm has come out with a new hydraulic scraper designed for truck use.

All dump trucks have always carried a little Giant, the hydraulic pump, capable of generating great pressure. This pump, has been employed to generate the pressure necessary to operate the scraper, as shown in the illustration. The ordinary pressure required is about 500 lb. for a three-ton truck. The pump and dump installation is not changed in any way. They merely cut out a section of the pipe running from pump to the dump cylinder and install a three-way stop cock. In one position the dump body operates. Throw the lever one quarter turn, which closes the passage of the dump cylinder, and this applies pressure to the pump cylinder, where same is held by a combination check and relief valve.

A pilot valve in check, which lists, allows a small volume of oil to escape, thus reducing pressure on scraper. When pressure is reduced, the lever is lifted further and the springs raise the scraper and force oil out of the cylinder, returning it to the dump cylinder through the same pipe. The dump cylinder is the reservoir.



View of Truck Equipped with New Root Hydraulic Scraper

Continental Motors Now More Compact

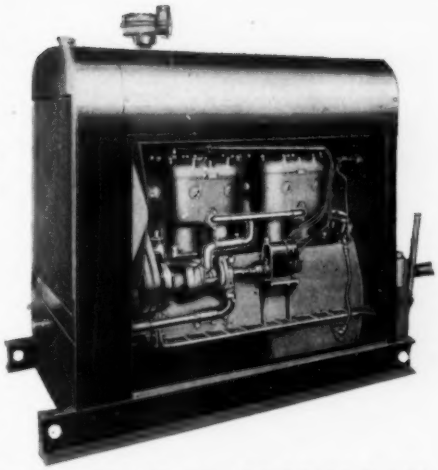
Continental Motors Corporation has been extremely active this year in widening its scope of activities in the industrial field, with the result that a larger number of industrial manufacturers can now apply heavy duty Red Seal Industrial Engines and Power Units to their equipment, because of the latest changes that have been made.

These new developments known as the "A" series; several new engines as well as the complete industrial series with a power range of from 5 to 96 horsepower will be effectively displayed in the Continental Booths, at the Road Show.

The "A" series particularly will create wide interest. This consists of a transformation of several of the present well known Continental Industrial power units, changing the entire housing to lesser dimensions, for the purpose of making them more compact as well as to increase its potential market. Many new features made possible through these dimensional changes have been added.

Among the several new Continental Industrial Power Units to be added to round out the Continental series is the Model P-52. This consists of a heavy duty four cylinder vertical head type engine with a five inch bore and six inch stroke making it the largest of the Continental fours. The total piston displacement is 471.2 cu. in. total for four. It is a slower speed engine capable of developing 52.5 horsepower at its recommend governed speed of 1100 r.p.m.

Several departures from regular known Continental practice in motor design and construction will also be displayed in the form of a six cylinder overhead valve series. These are built exclusively to serve both the commercial and industrial fields.



The Heavy Duty Continental Red Seal Industrial Power Unit, Model P-52A, Is More Compact than Earlier Models.

Several display boards will be utilized to acquaint those attending the show with the various and major parts that make up the Continental Motor.

To those who are particularly interested in observing Red Seal Continental Industrial engines and power units under actual performing conditions, numerous Continental powered installations covering practically the entire diversified industrial field will be on display throughout the show and performing.

Western Crawler Dump Wagon

A feature of the Western Wheeled Scraper Co. booth will be the new Western 7-yard crawler dump wagon on Athey truss wheels. This wagon is designed to use the full power of a crawler tractor to advantage in the moving of dirt. The Athey truss wheels carry 90 per cent of the load and enable the wagon to operate with a maximum load whenever and wherever a crawler type tractor can operate.

Although the wagon looks large and in practice it is loaded to carry 8 cu. yd. or more, owing to the special construction of the Athey truss wheels, it operates very easily. Under normal conditions, a single "Caterpillar" 60 is able to handle with ease a train of two of these wagons loaded to capacity.

This crawler dump wagon is an all-steel wagon of great strength. The side sheets of steel are $\frac{7}{8}$ in. thick, reinforced on the edges against the hardest kinds of shocks from power shovel loading and like all Western machines is hot riveted as far as is practicable. There are two sets of bottom dump doors, one in front and one back of the axle, which can be dumped simultaneously, or the back doors can

This New Model F Distributor to Be Seen in Etnyre Booth

be dropped and raised independently of the front doors. The doors are wound up by the operator by means of a ratchet attachment at the front, much as on a standard dump wagon. The wagon can be used in connection with power shovel or elevating grader.

Besides this machine, the booth will feature the Western Hot Patch Asphalt Outfit, formerly known as the Anderson Road Repair Outfit and manufactured by Littleford, but now manufactured by Western, under this new name. Another interesting machine shown by Western will be the new Western road grader.

This is a heavy blade machine designed primarily as a ditch digger, but which is equipped with all the refinements necessary to adapt it to the heavy road maintenance work required in the southern states. The machine weighs 5,300 pounds and is the lightest weight machine that can stand the strains behind a crawler type tractor, 40 horsepower down.

The machine has the same refinements as found on the No. 1 Patrol Grader, including ball and socket joints, cut gears, and is built along the same general design, differing however, in size and weight. It contains non-reversing gear, offset mechanism for blade and circle. The rear axle pivots and shifts back and forth under the frame. This shifting operation is controlled by non-reversing cut worm and gear and pivots by the action of a screw. The lifting gears are the same size and weight as those of the No. 20 grader, having the largest gears with the biggest teeth of any grader on the market.

The wheel base is long enough so that a scarifier can be used in front of the blade and a back-sloper can be handled on the end of the standard blade which is 8 ft. The machine can be furnished with blades of 8 or 10 ft.

New Features Seen in Etnyre Distributor

New and important features to be shown in connection with heavy bituminous distributor by E. D. Etnyre & Co. are: tank gauge, thermometer with visible dial and snap connection for attaching filling tubing to distributor. These are all shown in the sectional illustration. A gauge to register accurately the amount of material in the tank at all times fills a long felt want and does away with the messy and awkward method of sounding. Furthermore, it indicates when the tank is full without peering through the manhole and eliminates the danger of overfilling the tank when filling with the pump and with manhole open.

The 8-in. dial with black graduation marks and figures on a white enamel background make it very legible. The indicator travels through an arc of over 300 deg. and with the 25 gal. division marks, readings can be made within an accuracy of 5 gal. The open dial type thermometer provides an easy and convenient means for observing the temperature of the material at all times. It registers from zero to 500 deg. Fahrenheit and is located in plain view of the operator and enables him to regulate burners intelligently while machine is standing or moving. The thermometer is a high grade mercury actuated instrument extremely accurate and dependable. It is placed where there is the least possible danger of being damaged, and well protected, with the dial coming flush with rear flue box plate.

There is no one who has had the least experience in handling heavy oil, tar and asphalt that would not readily recognize the advantages of a union connection of the quick acting clamp type that would eliminate the slow and exasperating operation of starting and tightening a union nut in which the threads are full of frozen material. The Snap Union Connection that has been just recently developed has met the approval and praise of all who have used it.

Where it would require at least 2 minutes for 2 men to make up the ordinary threaded type union connection so common on distributors, 1 man can connect or disconnect the filling tubing with this new device in 10 seconds without tools and with less exertion, according to the manufacturers.

One-half of the union connection which is made of malleable iron with a brass seat and adjustable collar is screwed onto the end of the intake pipe extending to the outside of the distributor frame and the other half is screwed onto a piece of 3-in. pipe 16 in. long, which in turn is attached to the end of flexible tubing by the use of a 45 deg. elbow. To make connection, the lever is thrown forward or toward the tank. The hinged hooks engage the lugs on the adjustable collar and the joint is tightened by bringing the lever back and locked as it passes dead center. Means are provided, although not shown here, for self-alignment of the 2 halves of the coupling so that a perfect seat and tight joint is insured by only a slight pull on the lever.

Like all of the other special features on the Etnyre distributor, these 3 are very practical and useful and can be seen at booth WW84 during the Road Show.

Other attractions help to make it profitable for anyone interested in the better methods of road construction and maintenance to attend.

Heller Shows New Wrench Line

Heller Brothers Co., Newark, New Jersey, recently placed on the market, the Masterench—a new product, which is made of chrome vanadium steel. This wrench is made with either smooth or rough jaws, and in 6, 8, 10 and 14 in. sizes. It is a uniform product, made from highest quality, carefully heat treated chrome vanadium steel, and is covered by an unconditional guarantee.

The Masterench is self-adjusting and ratchets and fits various size nuts. It is so constructed, that it will grip a smaller nut harder than a large one. It is ready for instant use at all times, and takes hold of every size nut within its range, regardless of whether the nut is hexagon or square. A further feature is, that this wrench will not round the corner of the nuts, as does the ordinary wrench, it is claimed.

There is no play between the jaws, since the physical contact of the Masterench increases with the load on the work; it conforms itself to the shape or outline of the nut, instead of the opposite. The company claims that there is no man strong enough to break the Masterench without resorting to additional leverage, and if such leverage be applied, the only result will be, that the Masterench will not break, but the thread of the nut or bolt will be stripped.

Made of chrome vanadium steel, this new wrench is drop forged and milled. It works in the most inaccessible places and can be used at an angle of 45 deg. At present, only 6, 8, 10 and 14 in. sizes are offered by Hellers, but larger types of the Masterench are in process of manufacture. These can be had in the smooth jaw type for use on nuts and bolts, or with a pipe jaw, for pipe and shaft jobs. Even if a pipe lies along a wall, this wrench will loosen or tighten it, say the manufacturers. It grips like a vise, it is said, and never slips. For general repair work, for implement use, and for getting at nuts, bolts, set screws and parts on cars, trucks and tractors, the manufacturers state, that the Masterench will prove a great boon to repair man, machinist, motorist, farmer or for any one using a wrench.

Perry Shows Improved Scraper

The Perry Company, of Sidney, Ohio, has announced important changes in their automatic scraper. This improved model will be on display at this year's show. The scraper is available in two sizes, 16 cu. ft. and 27 cu. ft.

The Improved Perry embodies a valuable mechanical change in the loading mechanism that accomplishes three very important results.

(1) It doubles the leverage which the operator has over the load.

(2) It practically eliminates mechanical friction in getting the load out of the ground.

(3) Through elimination of frictional resistance and reduction of torque the improved Perry has more than double the strength of the old style.

The double leverage is accomplished by reducing the distance from the center of the rocker shaft to the point of contact between the rocker arms and the loading stops to 2¾ in. instead of 5½ in. as formerly.

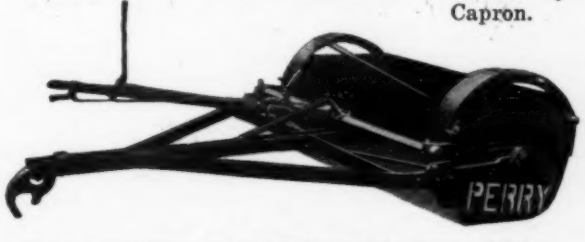
The elimination of frictional resistance in getting the bit out of the ground is accomplished in the new design through keeping the point of contact between the rocker arms and the loading stops at all times above the "center line" between the two pivotal points.

When getting the Perry bit out of the ground with its load, the rocker arm revolves in a clockwise direction and the loading stop which is attached to the bowl revolves in a counter clockwise direction.

On the old style where the loading point of contact was below the center line, these two arcs overlapped below center making it necessary for the operator to push against this frictional uphill load which increased the resistance enormously.

On the improved type with the point of contact always above the "center line," these two arcs always travel away from each other and the only load that the operator has to lift with his doubled leverage is the actual weight of the dirt and experience has shown that there is practically no situation under which the operator cannot easily get the bit out of the ground with the tractor in forward motion, unless the bit be caught under a solid ledge of rock or a large unbroken root or some such obstruction which has no business to be in the path of an earth moving tool. The greater ease of operation in the improved Perry is easily noticed.

By setting up the point of contact between the rocker shaft and loading stop to a distance of only 2¾ in. from the center of the rocker shaft instead of 5½ in. on the old type the torque or twisting leverage has been cut in half which has the effect of doubling the strength of the parts that are subjected to the greatest strain but the improved design by further eliminating so much unnecessary strain increases the factor of safety to many times that of the old style Perry.



The Improved Perry Automatic Scraper for Tractor Haulage

Marsh-Capron to Show 10-S Mixer

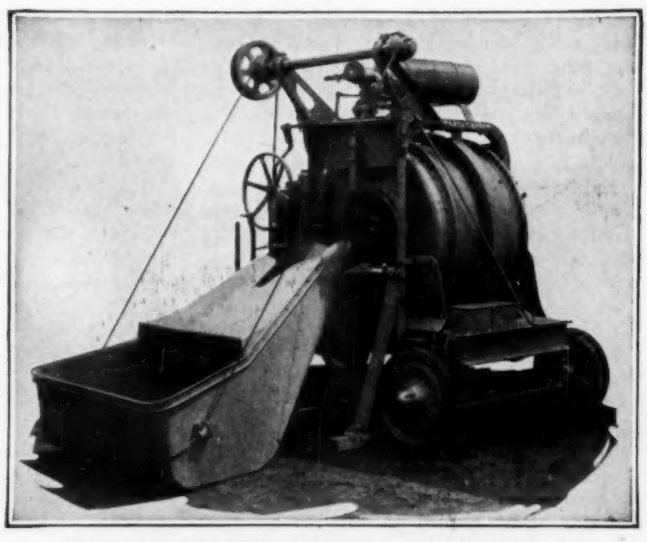
The 10-S mixer that found wide favor with road builders when introduced during the summer and two new products of the Marsh-Capron Company, Chicago, will be exhibited at the Cleveland Road Show in January.

Several improvements of design were introduced in the 10-S mixer, including a large drum, built in accordance with the latest recommendation of the Mixer Manufacturers' Bureau of the A. G. C., a stream-line power loading skip, discharge chute of special design, Timken bearings in the drum rollers and stronger frame construction.

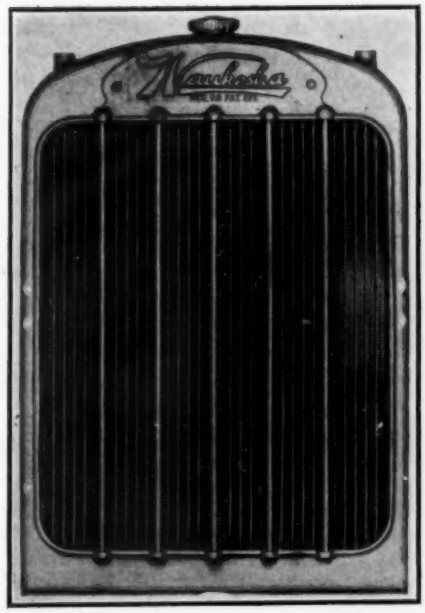
Speed in charging is secured by the large discharge opening on the power loading skip and the steep discharge angle, and by the large 23-in. charging opening of the Marsh-Capron type drum. This opening is 3 in. greater than the standard size. Speed of discharge, 10 seconds or less, has been secured also by a large 20 in. discharge opening on the drum and by a specially designed chute.

Fast mixing action due to broad blades, one man control, and a guarantee on the tracks, drum roller shafts, drum roller bearings, and the drum itself, are other features of the machine.

The new products to be exhibited are the Mechanical Hoeman with a hoist which will increase its versatility and make it doubly valuable for plaster and mortar mixing, and a sawrig embodying all the best features of present-day machines and some advances engineered by Marsh-Capron.



The Improved 10-S Mixer Shown in Marsh-Capron Booth



Young Radiator for Heavy Duty Waukesha Power Unit.

Young Announces Line of Better Radiators

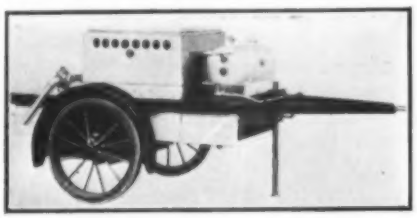
A line of what is described as greatly improved radiators for heavy duty service is displayed by the Young Radiator Company, of Racine, Wis. A stronger and more rugged tube system that retains a high cooling efficiency, and that insures a tight fit between tube and fins, together with hardened copper fins that can take a lot of punishment, are described. This company now makes radiators to meet the requirements of various engine manufacturers, and to render service on all types of power construction equipment. The new core construction is said to be the result of long research and a step in advance.

New Littleford Traffic Line Marker.

Littleford Shows Improved Line Marker

A feature of the booth of Littleford Bros., of Cincinnati, will be the Littleford Traffic Line Marker, shown this year for the first time.

The marker is usually operated by hand when used for marking traffic zones in cities and towns, but for county and state highway work it is usually mounted on an automobile, for which attachments are supplied. For center marking highways it is possible to mark 8 to 10 miles per day, using about 4 gal. of paint to the mile when operating the machine attached



New Tool Heater Announced by Littleford.

to an automobile. The paint flow is automatically regulated by the speed at which the machine moves. The Littleford Traffic Line Marker is equipped for marking either a 4 in., 5 in., or 6 in. wide line.

The same manufacturers have added to their line of road and street construction and maintenance equipment, an oil burning tool heater known as their No. 90, which is shown in the accompanying illustration.

It is really a combination tool heater and asphaltic cement kettle. The capacity of the heating compartment is more than fifteen paving tools, such as tampers, smoothers, shovels, rakes, etc., and tools properly heated for paving work can be withdrawn in less than five minutes after they are placed in the heating compartment. The asphaltic cement kettle has a capacity of 50 gal. and makes an extra melting kettle for ordinary repair work unnecessary. The kettle will produce hot melted material ten minutes after the burners are started.

This tool heater is said to be free from smoke, sparks, and ashes, making it very desirable, especially for work in congested districts. The Littleford Tool Heater No. 90 has high carbon steel axles with roller bearing wheels, making trailing safe. Rubber tires can be provided, the addition of which makes this tool heater a high-speed outfit.

Utility Openings Need Not Block Traffic

A new method of pavement repair and the protection of the openings during the repair period has been tried out in St. Louis that is said to give a good patch after the pavement has been opened for utility repair work, and that minimizes the time during which traffic is kept off the patch. This method and the necessary equipment are sponsored by a local organization that will soon make the plan available for other cities. Since part of the plan of the organization sponsoring this method is the assumption of all liability from the time the patch is started until the time the work is completed, the idea has been endorsed by the Legislative Committee of the St. Louis Master Plumbers' Association, and will be of particular interest to street authorities, plumbers, water works superintendents, and utilities elsewhere.

By this method the repair can immediately follow backfilling and tamping, and the opening is protected by a special cover while the patch is being made, thus eliminating the need for barricades except when the men are actually at work. With the new method, too, the old method of backfilling and mounding the dirt, covering with a loose layer of brick that has to be replaced each time a rut is developed until full settlement has occurred and the making of the permanent patch is possible, has been eliminated, thus eliminating a hazardous spot in the street.

Under the supervision of the City Inspector, the ditch is backfilled and tamped as usual up to within 14 in. of the pavement level. The company then protects the opening for the night with the special cover known as the Stelzer Trench Cover, made and reinforced to withstand the loads and impacts that would occur when a 10-ton truck passes over it.

The use of this cover is shown in Fig. 1, demonstrating how it is carried by the solid material on each side of the trench, and the structural scheme with the hinged doors below the street level, preventing the cover from shifting its position under impact.

The next step is that of permanent repair. Both sides and ends of the trench are trimmed back to form a shoulder of solid earth upon which a concrete patch will be carried. Angle bars are driven through the shoulder and interlaced with reinforcing bars running lengthwise and crosswise over the fill. The concrete is then laid to within 4 in. of the surface of the pavement, using quick hardening cement that will carry traffic within 24 hours. This concrete is tamped to the proper surface, and asphalt brick are immediately laid thereon. The cover is then replaced and left in position for 24 hours, at which time the patch is able to carry traffic.

Fig. 2 shows this completed patch protected by the cover. Note how the underfolds of the cover tuck beneath the arch. The brick are set on edge, and are said to form a permanent and watertight repair.

The sponsors of the new method and the cover equipment involved have hopes of developing the idea on a national basis since it affords a definite basis for estimating such work, a fixed price for each type of repair, and

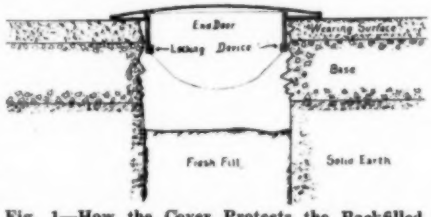


Fig. 1—How the Cover Protects the Backfilled Trench.

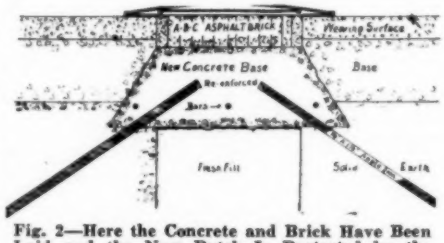


Fig. 2—Here the Concrete and Brick Have Been Laid and the New Patch Is Protected by the Cover.

assumes the full responsibility for liability ordinarily assumed at some cost by the plumber or utility making the repair.

Arrangements have been made with a reliable insurance company to issue a liability policy that will cover any person, firm or corporation for whom this company will do work, this coverage starting at the time the job is ready for the service.

The company offering this service and equipment is the Asphalt Brick Service Company, St. Louis, Mo. The idea, it is said, has been severely tested on St. Louis streets and has proven practical.

New Transmissions and Clutches

The Brown-Lipe Gear Company, Syracuse, N. Y., is showing two new transmissions and a new clutch, in addition to their line of more well known transmissions and power take-off. The new clutch is known as the 14 in. Industrial Clutch, while they are also showing for the first time their Model 51-5S transmission, especially designed for road construction service, and their Model 20-4S transmission.

New Equipment in Blaw-Knox Exhibit

General improvement marks the Blaw-Knox line of equipment to be shown this year. Almost every item has been radically improved by valuable innovations. The new dragline bucket will also be shown. Their Blaw-Knox road forms will be 6 in. wide at the base, and they will have an improved lock joint and added reinforcement. The key has been given a shoulder to take the releasing blow, and cotterpins have been replaced by heavy bolts. Their Universal forms now have the same staking system as the Blaw-Knox forms. The inundation apparatus has been further improved with an air cylinder shock absorbing system of large capacity, with automatic feeders, thus making the apparatus mechanically more practical on road work. The shaker blade system has been redesigned to provide greater uniformity of feeding the sand into the inundator.

This company has also made decided improvements in its apparatus for the measurement of aggregates by weight. The 1928 batchers are automatic. Improvements make for quicker and more positive operation. Weighing batchers have been equipped with auxiliary dial and baffles, and both aggregates and cement are said to be weighed accurately to the pound with great speed. The automatic counterweighted doors are now a part of the hopper, thus increasing the accuracy of the plant. Larger openings in both compartments for removing surplus material from batch and a double acting dog arrangement for operating the gates without requiring the operator to shift his position in front of the scales still further increase speed and accuracy.

The volume batchers have also been improved with a reliable, quick adjusting system for adjustment of volume. The clamshell buckets have been improved with sand sealed bearings and ball bearing sheaves. A 100 ton line of portable pedestal type bins has been added to the line. A steel batch box has now been produced that is adjustable for both 21-E and 27-E pavers for the industrial haulage job. The new dragline bucket is said to be attracting considerable attention.

New Saw Rig Does Variety of Work

The booth of the Jones Superior Machine Company reveals a new gasoline power saw rig that is small enough to be portable but that can handle form lumber and other work at a good speed. This new Superior Speedster Saw Table is powered with a 1½ h. p. Briggs & Stratton air cooled gasoline engine. It is said to be capable of ripping 2 in. lumber at the rate of 20 ft. per minute, and of cutting off 3 by 6 lumber in less than 2 seconds. It is so light that it can be moved about the job like a wheelbarrow, yet sturdy enough to stand rough handling. The table is of heavy steel and tilts sideways to an angle of 45 degrees The saw arbor is mounted on Timken Roller Bearings. In general, the saw is well built of steel construction, and designed to all sawing operations.

Armco Exhibits New Culvert Improvements

Included within the display of the Armco Culvert Mfrs. Association are a number of items of more than ordinary interest to road builders. Some of these are distinctly new and indicate important improvements which will increase the economy and facility of road construction and maintenance.

In the matter of culvert durability the Association has for some years been studying the problem of erosion by sedimentary streams. The solution developed from this study is a pipe with a paved invert, a specimen of which is on display. Wherever erosion is a factor the new product should greatly increase the economy of culvert installations. This is the first time, it is said, that a concerted effort has been made to solve this troublesome problem in road maintenance.

Another development of almost equal interest is newly perfected fittings for culvert and drainage pipe. The new Armco fittings, which include every detail likely to be required where the pipe deviates from a straight line, are sturdy in construction and workmanlike in appearance, and do away with the need for special designs for each job.

The foregoing are important contributions to the road building art, but the Armco exhibit includes even more. An animated display showing the operation of perforated iron pipe is designed to attract attention to the effectiveness of this type of drainage. A model showing safe street intersection drainage by part circle culverts is also of interest.

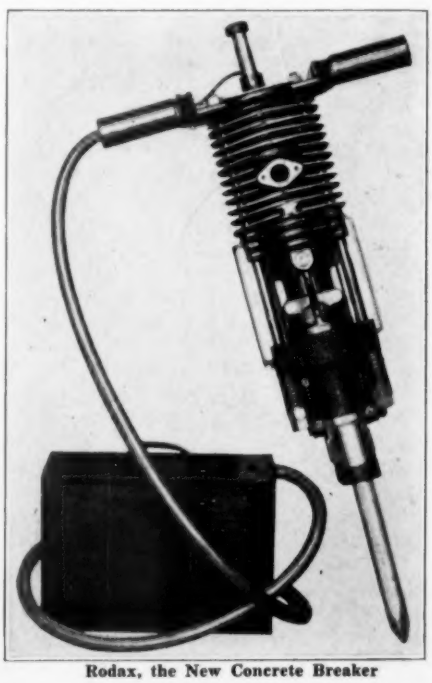
The New Armco Culvert with the Paved Invert

To Show New Gas Hammer

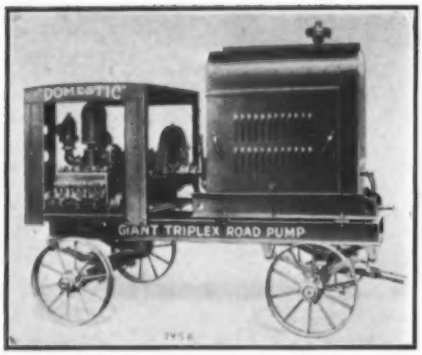
The Milwaukee Gas Tool Corporation of Milwaukee, Wis., has developed and perfected a new labor-saving device designed for pavement breaking. This machine has been tried and proven, and for the past two years a number of them have been in operation, working under the most severe conditions on all types of jobs. This device is on display in their booth.

This machine will be known as "Rodax"—a gasoline hammer—claimed to be the most economical concrete breaker now on the market. It is radically different from any other equipment now in use. It is in reality a gasoline hammer of a new type which has no flywheel, connecting rods, cam shaft or bearings,—and its simplicity and rugged construction makes it practically fool-proof. The piston operates as the hammer, striking more than 1,000 terrific blows per minute. These blows are transmitted through an anvil direct to any standard cutting tool which may be used. The entire unit weighs but 85 pounds and will operate all day on two gallons of gasoline. It requires no outside equipment to operate it. It is a self-contained unit.

This machine will be manufactured by the Le Roi Co., of Milwaukee, Wis., for the Milwaukee Gas Tool Corporation, who will market it through contractor equipment distributors. Arrangements for distribution have already been completed with many of the leading contractor equipment supply houses through many sections of the country, and by the first of the year this machine will be represented throughout the country.



Rodax, the New Concrete Breaker



Giant Triplex Road Pump Shown This Year in Domestic Booth.

Domestic Shows New Pump

Of particular interest, in the exhibit, of the Domestic Engine & Pump Co., will be the self oiling, Hyatt roller bearing equipped Giant Triplex Road Pump.

This "Domestic" Giant Pump is assembled with 20 and 35 hp. 4 cylinder industrial type engines and for pumping capacities of 60, 80, 100 and 150 gallons per minute against back pressures up to 500 lb. This pump has a positive pressure oiling system which supplies the lubricant, under pressure, direct to every bearing. The pump is entirely enclosed, is dust and grit proof and oil retaining. Hyatt roller bearings are standard equipment on the pump drive shafts and pinion gear drive shafts and the standard mounting for this pump unit is the steel wheel trailer with springs.

There is a "Domestic" Giant Pump Unit to meet the requirements of every road builder regardless of size paver he uses, distance he has to force water or the method he may use to cure his concrete.

New Barnes Pump to Be Shown

The new Barnes Triplex Road Pump, to be seen at the show, is mounted on a heavy duty trailer type truck with three point suspension and spring mounting. Roller bearings are used on the intermediate and drive shaft. Crank case totally enclosed in a dust-proof case lubricated by a positive oiling system. Heat treated gears are used throughout. Another unusual feature on this pump is that the crankcase end and water end of the pump are cast in separate pieces.

Pump Model Number L308A has many unusual features not found on drainage pumps of this kind, such as heat treated steel gears, replaceable shell bearings, all moving parts totally encased in a compact, dust-proof housing and lubricated by a positive oiling system. Pump and engine units are connected by a flexible coupling and are mounted on a drop type frame, allowing extremely low center of gravity.

Barnes Double Diaphragm Pumps now have both pumps cast in one piece which combines lightness and simplicity and at the same time maintaining the strength of the outfit. The single diaphragm and the double diaphragm are positive oiling. They are regularly equipped with heat treated steel gears which are enclosed in a dust-proof case.

Galion To Show New Machines

The Galion Iron Works and Mfg. Co. exhibit at the road show will cover a full line of modern road rollers, road graders and other road equipment. Their more than 2,500 sq. ft. of space will be full of interest for every road builder or maintenance man.

No announcement is being made of just what will be shown, but officials of this progressive concern state that several new and interesting developments in the Galion line will be on exhibition there for the first time, as well as many Galion machines that are well known, such as the Galion Master Roller and the Galion McCormick-Deering E-Z Lift Motor Grader.

Sullivan Exhibit Contains New Products

Sullivan Machinery Company has reserved a space at the South end of the West Hall at Cleveland. In this booth will be shown the 110 ft. and 310 ft. gas engine driven portable compressors; a semi-portable direct connected motor driven compressor in operation, supplying air for an exhibit of Sullivan compressed air tools, including new types of Hammer Drills, Clay Spaders, and Concrete Breakers; also the Sullivan Turbinair Portable Hoist; also a completely equipped blacksmith shop consisting of a Class C Portable Drill Sharpener, and a Sullivan GF-2 Portable Gas Fired Drill Steel Heating Furnace in operation.

In addition, there will be exhibited one of the new Sullivan Scraper Hoists with double drum, electrically operated by 25 h. p. motor.

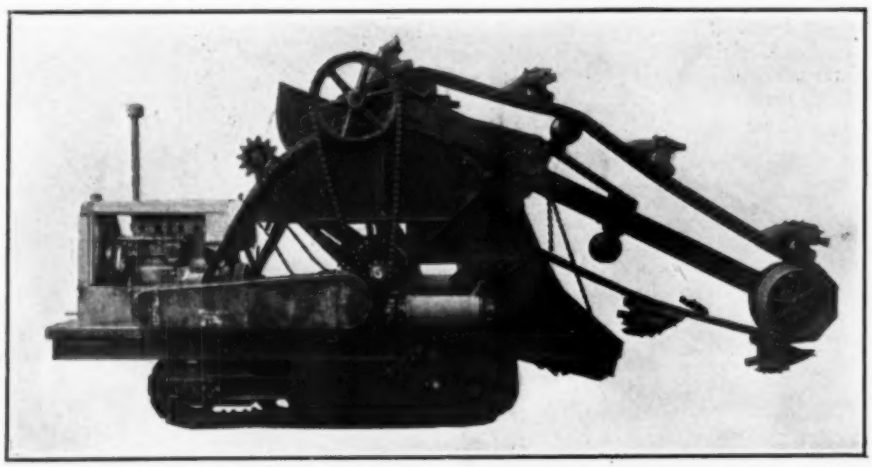
Dot Electric Lubricator a New Device

Lubrication is a necessity for machinery. It is not surprising therefore that special lubrication systems have appeared on the market, and that constant improvement is to be observed. Judging from the Dot exhibit, this line is no exception. For in addition to their usual display of up-to-date lubrication equipment and their lubricant on display, they are showing for the first time their new Dot Electric Lubricator. The Dot line provides for the lubrication of power shovels, hoists, pumps, scrapers, dredges, electric locomotives, pavers, mixers, and other paving equipment. The new electric lubricator is a self-contained, motor driven, unit, having a capacity of 25 lb. of grease or oil. The control of the tank and motor is centered at the nozzle, making a one-man operated unit. It is easily portable, economical, and dependable, according to the manufacturers.

New Public Service Trencher

The Austin Machinery Corporation of Muskegon, Michigan, announces the completion of a small type trench machine. This will supply the needs of contractors engaged in digging shallow sewers and laterals—gas, water, and pipe line work as well as electric conduit trench. This machine will be known as their model 100 and is the result of Austin accumulated experience in the design and manufacture of larger trench excavating units.

First showing will be at the road show. The machine is now in production and will be available to contractors after January 1st.



The New Austin Public Service and Water Line Trencher

Lincoln to Show Their Maintainer

A special "ironing" shoe, in combination with a cutting blade, is the outstanding feature of the Lincoln Road Maintainer which is to be shown at the Road Show.

The Lincoln is a wheelless maintainer with an arched frame. A cutting blade is carried in front. The rear end of the frame carries a plate for crushing or rolling aside any loose earth left by the front blade. The "ironing" shoe is attached to the back of the cutting blade. Long levers working in notched quadrants provide adjustment of both the front blade and rear plate, in eight different positions. The "ironing" shoe is curved to present a broad bearing surface in whatever position it may be adjusted.

In this manner the shoe is made to serve two purposes. It keeps the angle of the cutting blade always constant with reference to the grade-line. Also, it "irons" out loose earth and clods, pressing them into the road surface.

The Lincoln maintainer is used in groups of three for wide roads—two abreast, with a third directly behind the space between the forward units. An adjustable spreader-bar keeps the forward units apart. Short chains connect the rear unit to the forward pair and the entire outfit is attached to tractor or truck by chains. A single unit may be used for narrow roads.

Speed, low cost, low maintenance expense, and the fact that it will not "jump" are the advantages claimed for the Lincoln Maintainer. The special shoe of the Lincoln has the effect of steadying it so that, even on the hardest soil, it does not jump around. Neither will it drop into holes in the road and scoop them deeper. This makes it possible to give a road a smooth surface with fewer trips over it.

The cutting blades are reversible, giving double life to the only part of the outfit which wears out.

First cost and replacement costs are very low in comparison with other types of road maintenance machinery.

The Lincoln Road Maintainer is made by the Lincoln Steel and Forge Company of St. Louis.

Trailer for Transporting Power Shovels

The Speeder Machinery Corporation, Cedar Rapids, Ia., manufacturers of Speeder gas and electric shovels, pull shovels, skimmers, cranes and draglines, in conformity with their policy of manufacturing machinery of the mobile, flexible and portable type have recently introduced a trailer, especially adapted for use in transporting the Speeder.

The new Speeder trailer is of the 2-wheel type. There are two 28-in. wheels with dual tires, each tire being 10 in. in width, making a total of 40 in. of rubber ground contact on both wheels. The estimated pounds for each lineal inch tire is 572.

In the development of the Speeder trailer special attention was given the maintenance of balance. The trailer is so constructed that only slightly more than 8,000 lb. weight is thrown on the tongue end, enabling the truck to maintain traction on the rear wheels under the most severe road conditions and yet not placing an excessive weight on the rear of the truck. The Speeder trailer can be successfully used with truck or tractor.

In a recent test made over the highways of New Mexico it is stated an average speed of 10 miles per hour was made over a period of 6½ hours. The trailer was loaded with a Speeder standard shovel attached to an old army truck of 5 ton capacity. The operator reported no difficulties whatever and that the trailer brakes were so efficient that the use of the brakes on the truck was found unnecessary, even on the steepest grades.

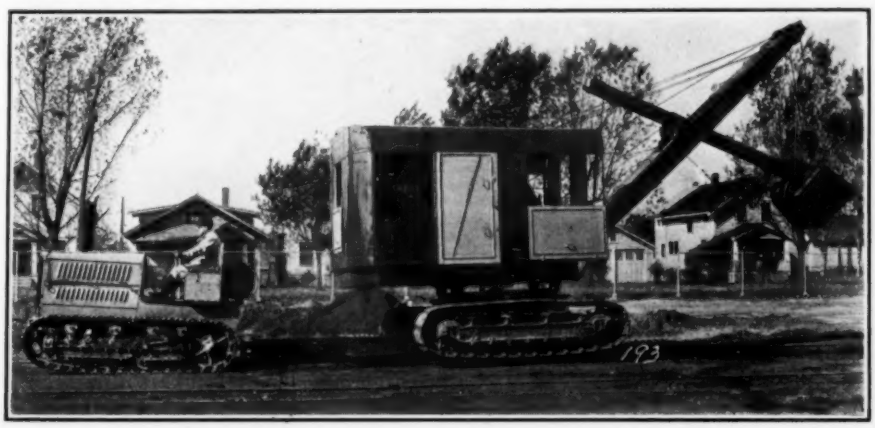
The Speeder trailer is claimed to be a departure from the usual type of trailer used for the transportation of heavy equipment. It is light in weight and compact, not bulky and cumbersome and the machine can be loaded or unloaded in exceptionally short time.

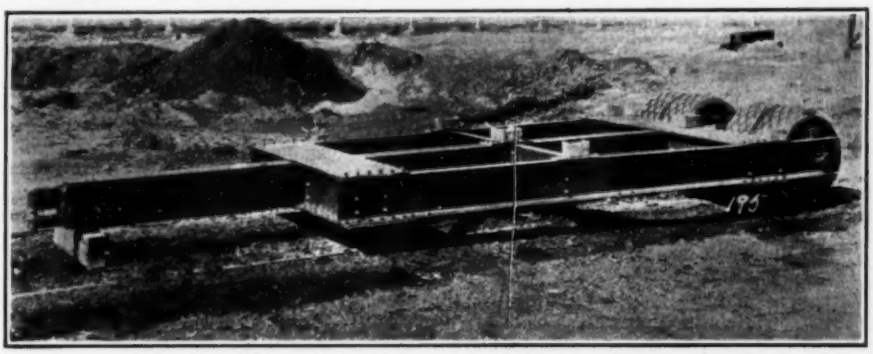
The Speeder trailer was developed in order to allow Speeder owners to secure more rapid transportation for their machines from job to job.

T. L. Smith to Show Improved Paver

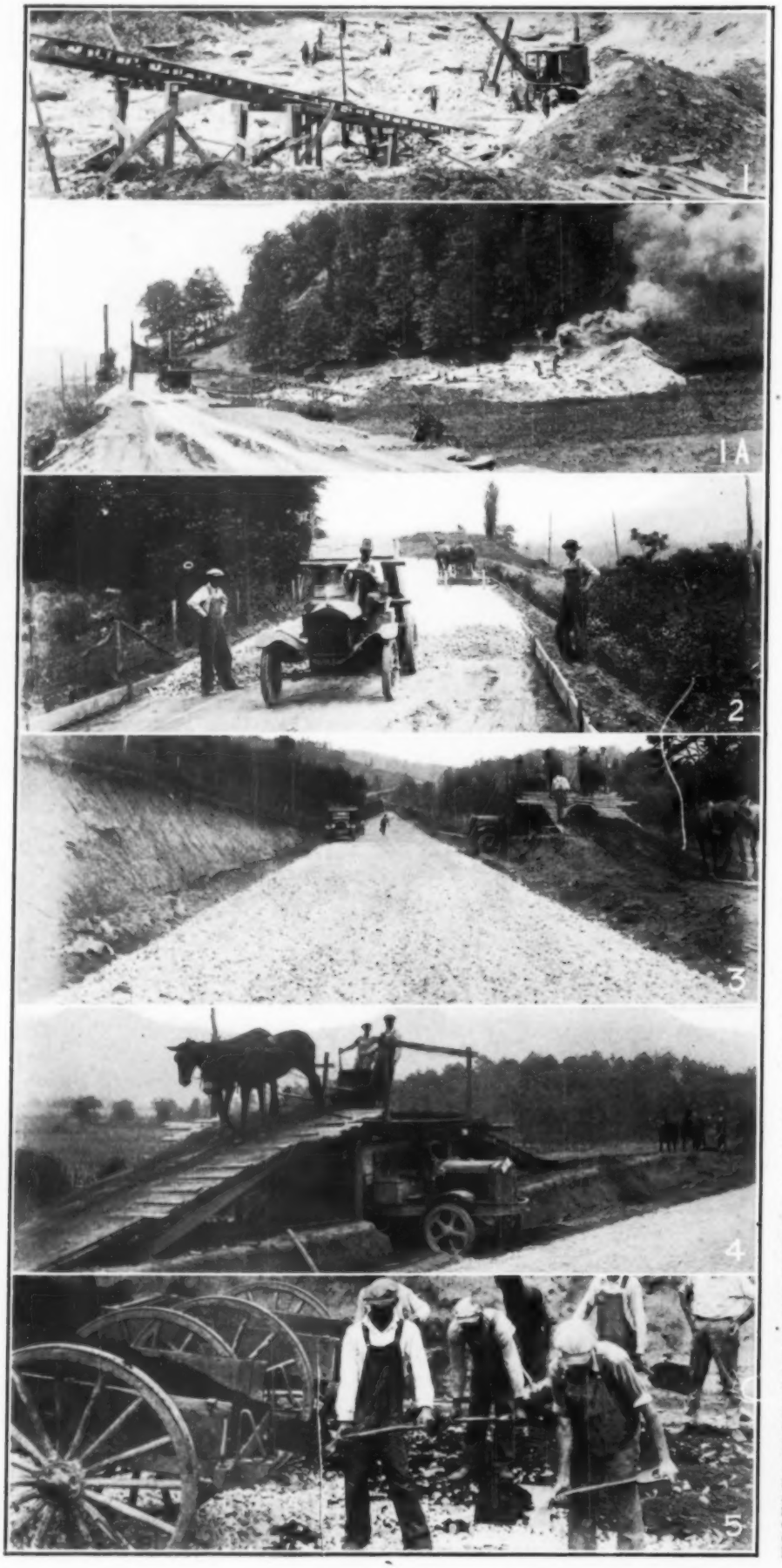
The T. L. Smith Company, Milwaukee, Wis., will have an interesting exhibit that will include a 27-E Paver of completely new design. Among its features will be the use of ball and roller bearings carrying the principal shafts, a 6-cylinder Waukesha motor as standard equipment, a two-speed traction, a weight increase of 7,000 lb. over the model of last season, a newly designed boom swing mechanism that gives easier swinging, a water measuring tank capable of measuring to the ounce, and a balance so accurate that the machine is said to be capable of working efficiently under conditions that would have made work difficult with older models.

Road Numbering and Marking in Pennsylvania.—Within the next year the Pennsylvania department of highways plans to change the numbers of all roads designated as Federal highways to correspond with the Federal numbers. This is to be done for the convenience of the public so that a road will bear the same number whether crossing two states or the entire country. The department also expects to employ an improved marking system for all highways. At present the numbers are placed on telephone poles along the road and frequently are difficult to see. Under the proposed system there will be metal signs by the side of the road carrying black numbers, on a background of yellow.





Above, Power Shovel Being Transported on Trailer. Below, the Trailer Itself



Clay-Bound Granite and Rock-Asphalt Top

Local Materials Handy to Roadside Used in Constructing Base for Georgia State Route 15

By H. L. FREDERICK

At many places along the scenic highway, known as Georgia State Route No. 15 and adjacent to the road is found granite in great abundance and also a fine quality of natural binding clay.

This particular quality of granite alone will not bond satisfactorily nor will it withstand the abrasive wear of modern day traffic when used as a wearing surface. Neither does the clay possess any particular quality; but by combining the two, that is, by constructing a clay-bound granite base, an opportunity is given to use the local materials.

Rock asphalt was selected for the wearing surface.

Placing Crushed Granite Base.—The method of constructing this clay-bound granite base with Kyrock wearing surface was as follows:

After the sub grade had been properly shaped and rolled, form boards were set along each side ready to receive the crushed granite.

The width of the granite base was 19 ft., this being 1 ft. wider than the Kyrock top.

The granite was crushed at the quarry, which was near one end of the job, and hauled in 1-ton dump trucks onto the roadway. It was there dumped into piles between the forms and spread to grade with a small horse-drawn road grading machine.

Such additional leveling of the granite as was required was done by hand. The metal, which was the regular crusher run of material with the dust

The Illustrations Show: (1) and (1A) the Method of Handling the Stone from Quarry to Roadway. A Steam Shovel Loaded the Fragments into Skip Car Operating on Incline from Pit to Crusher. The Nearness of the Granite Supply Made Possible This Convenient Arrangement at Minimum Cost. (2) Spreading Crushed Granite Base on Subgrade. Levelling of Metal Was Done with a Horsedrawn Grader Supplemented with Hand Tools Where Necessary. After the Granite Was Spread, Earth Shoulders Were Thrown Up Before the Forms Were Removed. The Granite Was Rolled with a 10-Ton 3-Wheel Roller Until It Was Well Compacted. (3) and (4) Granite Base Ready for Clay-Binding and Method of Loading Trucks with Binder-Clay at the Roadside. (5) and (6) Spreading the Binder-Clay on the Granite Course. The Clay Was Spread to a Depth of 2 in., After 10-Ton Roller Until Thoroughly Compacted. (7) Sweeper. (8) A Light Truck Carrying 2 Bbl. and Equipped with Hand Force Pumps with Spray Nozzle Attachment, Was Used to Paint Coat and Surface. A 60 Penetration Asphalt Cut-Back with Approximately 50 Per Cent Gasoline Was Used. (9) A Short Section Where,

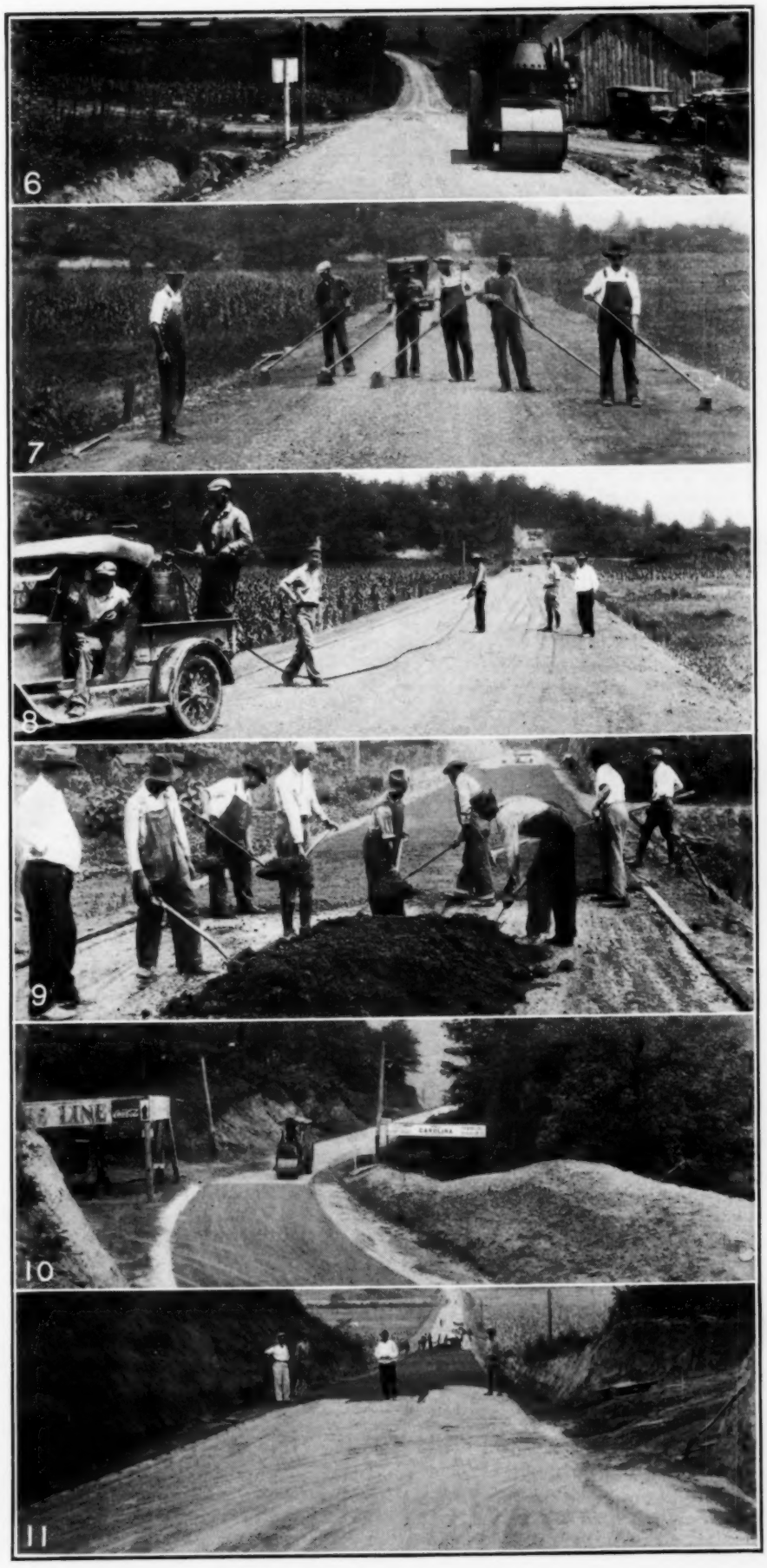
screened out, was then rolled with a 10-ton, 3 wheel roller, until it was well compacted. Then about 2 in. of clean Georgia clay was broadcast with shovels from the back end of an ordinary one-mule dump cart on top of the compacted granite.

Applying Clay Binder.—After the granite base had been completely covered, as above described, the entire roadway was scarified, or as some may call it, harrowed, with a flat semi-circular tooth harrow to a depth of about 3 or 4 in. This permitted the clay which had been spread on the top to sift down into the voids in the granite base.

Continuing this harrowing process several times backward and forward until it appeared that the clay and granite was thoroughly mixed; the mixture was then rolled until it was thoroughly compacted. The surface, of course, was not completely bonded, but additional binder material was then added to fill all the base or honeycombed looking areas. The additional binder material for this last or top course was similar to the clay used for the first course, only that more care was taken in the selection of this material, it being desirous that the finished top binder material should contain more sand than the other binder used. The idea being that if a sandy clay was used the excess clay would be swept off more easily when preparing the base to receive the surfacing material.

It was peculiar to this job and worth while mentioning here that in this section of Georgia there are no roads paralleling this main north and south road. There being no facilities for detouring it was, therefore, necessary to allow the traffic to use the road at all times during the construction or completely cut them off, and thanks to the cooperation of the contractors, Billiter & Oliver, no serious handicap was offered the traveling public while the road was under construction.

Preparation for Wearing Surface.—After the base had been constructed, as above described, it was then necessary



Owing to a Convenient Lane for Detouring, It Was Possible to Surface the Entire Width of the Road in One Operation. 2x4 Timbers Were Used to Align the Edges and in the Center to Establish the Grade for Raking the Loose Kyrock. On Other Sections the Kyrock Would Be Laid and Rolled on One-Half the Roadway at a Time, Allowing Traffic to Use the Other Half. As Soon as the Kyrock Was Rolled, Traffic Was Turned Over It and the Construction Crew Switched to the Other Side of the Road. (10) In Order to Leave Grades and Curves Clear of Obstructions for Night Traffic, This Section ad Others Similar to It Were Surfaced One-Half in the Forenoon, Rolled and Opened to Traffic, and the Other Half Surfaced and Rolled in the Afternoon, so the Entire Road Would Be Open to Traffic by Night. (11) Another Section of the Roadway Where a Convenient Lane on the Right Served as a Detour Which Permitted the Surfacing of the Entire Width of the Road at One Time for a Distance of About 1,200 ft. This Entire Section Was Surfaced with Kyrock, Rolled and Opened to Traffic on the Evening of the Same Day

to prepare it to receive the Kyrock surface which was done as follows:

A rotary power broom was used to sweep the excess clay binder from off the top. The clay was swept until over the entire surface the granite base was just visible. Hand push brooms were used to touch up the spots not adequately cleaned by the power broom.

A small amount of sandy clay on the surface is not objectionable, but the surface should be thoroughly cleaned of dead clay and dust.

The clay-bound base was next sprayed with an asphalt cut-back consisting of about 50 per cent A. C. of 60 penetration cut-back with 50 per cent of naptha. An additional 20 per cent of gasoline was added to this material on the job so that it could be applied with a hand spray pump.

The naptha and gasoline used to cut back the asphalt prime, or paint coat, gives it greater penetrating properties and assists it to dry quickly.

Laying Wearing Surface.—This paint or prime coat was applied at approximately 1/10 gal. per sq. yd. of surface, and was allowed to set or dry before the Kyrock surface was laid. It required from 2 to 3 hours in this climate for the material to dry; but generally the base was painted one day ahead of spreading the Kyrock surface.

As stated above, it was necessary at most places to let travel use the road all during construction, so only one-half of the road was painted and surfaced at one time and as soon as a reasonable distance was surfaced it was rolled and directly behind the roller the road was opened to traffic. The public had access to and used the road from the time the subgrading was begun until during the time the final kyrock top was being laid.

The local engineers for this division are E. M. Parker, District Engineer, Gainesville, Ga., and G. C. Reed, Resident Engineer, Clayton, Ga.

Cost of Painting Street Names on Curbs

Frank Ray, City Engineer of Colorado Springs, Colo., states that the cost of eight markings at each of 25 street intersections, applying a white coat one day and stenciling in black the next was:

½ gal. zone paint	$1.50
1 qt. lampblack	.25
2 days' labor charge	9.00

For 200 markings this made a total cost of $10.75 or $.0538 each. A set of interlocking brass stencils with separate letters cost $2.50.

$315,000,000 of Road Bonds Voted in 1927.—State or county bond issues for road improvements amounting to approximately $315,000,000 were voted during 1927.

Detailed Cost of Sheet Asphalt Pavement at Flint, Mich.

The city of Flint, Mich., operates a municipal asphalt plant for both construction and repairs of streets. We are indebted to H. C. McClure, City Engineer, for the following average detailed costs for the 1926 operations and for the cost of a sheet asphalt job at 382 Ida Ave., from Corunna Road to Miller Road.

Cost of Patch Work.—The following short account shows the average cost of making repairs in the city. This includes cutting out the patch and hauling away the old material.

Repair and Patch Work

	Per Sq. Yd.
Plant:	
Labor, supplies, repairs and depreciation	$1.40
Hauling	.06
Material—asphalt, binder stone, dust, sand	.49
Street:	
Labor, supplies, tools, rolling, moving	4.45
Laboratory and supervision	.10
Total per square yard	$6.50

Average Detailed Asphalt Costs per Square Yard
(1926 Operation)

CONSTRUCTION
1½ in. Binder—1½ in. Top

	Cost per Sq. Yd.
Plant:	
Plant labor—foreman, 11 men	$0.08
Crane and supplies	.03
Supplies—coal, grease, fuel oil, oil, power, lights, water, etc.	.115
Plant repairs and depreciation	.20
	$ .425
Hauling:	
Asphalt hauled from central plant to various streets	$0.06
Material:	
Asphalt (tank cars)	$0.20
Binder Stone	.10
Dust	.09
Asphalt sand	.10
	$0.49
Street:	
Street labor—foreman, 15 men	$0.09
Supplies—grease, oil, kerosene, etc.	.01
Tools, etc.	.005
Rollers	.02
	$0.125
Laboratory and supervision	$0.10
Total per square yard	$1.20

Asphalt Labor Rates and Hours

		Hours per day
Street:		
1 Foreman at	$55.00 per week	10
2 Roller operators at	45.00 per week	10
5 Rakers at	.70 per hour	10
3 Tampers at	.60 per hour	10
4 Shovelers at	.55 per hour	10
1 Laborer at	.50 per hour	10
Plant:		
1 Foreman at	$ 0.75 per hour	10 to 15
3 Mechanics and operators at	.75 per hour	10 to 15
1 Drum fireman at	.60 per hour	10
1 Night fireman at	.55 per hour	12
3 Laborers at	.60 per hour	10
3 Laborers at	.50 per hour	10
Superintendent	$ 75.00 per week	
Chemist	225.00 per month	
Hauling, 5-ton trucks at	2.50 per hour	

Weights of Material per Box or Batch and Prices

Binder, 1½ in.		Top, 1½ in.		Price per Ton	
Stone	1,000 lb.	Sand	1,150 lb.	A. C.*	$20.50
A. C.	70 lb.	Dust	350 lb.	Dust†	5.65
Sand	350 lb.	A. C.	145 lb.	Sand	1.32
				Stone	2.10
Approx.	1,420 lb.	Approx.	1,645		

Cost of Sheet Asphalt Pavement, 382 Ida Ave., Corunna Rd. to Miller Rd. Started 8/3/26; completed 8/6/26.

Labor:	
Plant labor was 365.5 hours at	$ 232.40
Street labor was 407.5 hours at	261.45
	$ 493.85
Material:	
Asphalt, stone, sand, dust	$1,429.21
Plant Expense:	
Crane and supplies	$ 87.15
Supplies	334.07
	$ 421.22
Street Expense:	
Supplies—tools, etc.	$ 29.05
2 Rollers—Total 47 hours, at $1.50 per hour	70.50
	$ 99.55
Hauling:	
Trucks—Total 68 hours at $2.50 per hour	$ 170.00
Supervision and laboratory	296.50
Plant repair and depreciation	581.00
Total cost (2,905 sq. yd. of binder and 2,905 sq. yd. top)	$3,485.83

*In tank car, †In bags.

Glossary of Terms in Road Field

Highway Engineering Words and Phrases Defined in Construction Manual of Ohio Department of Highways and Public Works

Words and ideas are just as much the tools of the engineering construction field as are the mixer and dragline. But the former are in the apparently abstract and hence need definition. New terms and new phrases come into existence and old words and phrases shade in meaning as time goes by. The following glossary of terms is a guide for all interested parties working on highway and bridge work in the state. It helps the engineer, contractor, director, supervisor, attorney and others to talk the same language in matters relating to highway construction.

GLOSSARY OF TERMS

Abrasion—The act of wearing or rubbing off or away by friction or attrition.

Abutment—A supporting wall carrying the end of a bridge or span and sustaining the pressure of the abutting earth. The abutment of an arch is commonly called a bench wall.

A. C. B.—Asphalt Cut Back—A heavy asphalt fluxed with naphtha to reduce viscosity. It is liquid at low temperature, but when mixed with aggregate and exposed to the air rapidly loses its fluxing agent, leaving a viscous matrix.

A. E.—Asphalt Emulsion—A mixture of asphalt and water which has an emulsifying agent incorporated. The consistency can be modified by the addition of soft water. The emulsion is broken by agitation, such as mixing with stone or by chemical action of either acid or base, or by physical action of mixture with dust. The asphalt is precipitated, leaving water content free.

Annealed—Subjected to a high heat and cooled by a gradual process for the purpose of softening and rendering less brittle.

Approach Slab—A reinforced concrete slab spanning the backfill behind the abutment.

Asphalt—Solid or semi-solid native bitumens, solid or semi-solid bitumens obtained by refining petroleums, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt on the application of heat, and which consist of a mixture of hydrocarbons and the derivatives thereof.

Arch—A curved structural member which spans an opening and supports the adjacent members by resolving vertical pressure into horizontal or diagonal thrust. **Arch Bridge**—A bridge whose main members are arches. **Bow String Arch**—An arch having a bottom chord. **Filled Spandrel Arch**—An arch bridge, the roadway of which is supported by a fill of earth or other material over the arch ring. **Open Spandrel Arch**—An arch bridge, the roadway of which is supported by columns from the arch rib. **Through Arch**—An arch bridge, the roadway of which is below the crown of the arch. **Arch Rib**—An arch member of a bridge in cases where the roadway is supported by two or more separate arches per span. **Arch Ring**—The arch member of a bridge in cases where the roadway is supported by a single arch for each span.

Arris—The external edge formed by two surfaces, whether plane or curved, meeting each other.

Axis—A line around which the parts of a body or system are symmetrically arranged.

Back Wall—A wall projecting from the bridge seat to the top of the earth fill, to prevent the earth from flowing onto the bridge seat, and to support the approach slab.

Base Plate—Plate upon which a rocker or roller rests.

Batter—The slope or inclination of the face or back of a wall from a vertical plane.

Batter Pile—One driven at an inclination to resist forces which are not vertical.

Berm—That portion of the roadway extending from the edge of the pavement to the inside of the ditch.

Billet Steel—Steel cast in billet form, either by the Bessemer or open hearth process. Does not include high carbon or rerolled steel.

Binder—A foreign material introduced into the mineral portion of the wearing surface for the purpose of assisting the road metal to retain its integrity under stress, as well as, perhaps, to aid in its first construction. (2) The course, in a sheet-asphalt pavement, frequently used between the concrete foundation and the sheet-asphalt mixture of graded sand and asphalt cement.

Bitumen—A mixture of native or pyrogenous hydrocarbons and their non-metallic derivatives which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide.

Bituminous Concrete Pavements—One composed of broken stone, broken slag, gravel, or shell, with or without sand, Portland cement, fine inert material, or combinations thereof, and a bituminous cement incorporated together by a mixing method.

Bituminous Macadam Pavement—A pavement having a wearing course of macadam with the interstices filled by a penetration method with a bituminous binder.

Bleeding—The exudation of bituminous material on the pavement surface after construction.

Bolster—A casting supporting the fixed end of truss or girder.

Breast Wall—A wall built to prevent the falling of a vertical face cut into natural soil.

Bridge—A structure for carrying traffic over a stream or gully, the paving material or wearing course resting directly on the floor of the structure.

Bulking—The separation of the particles and increased volume of aggregate due to the presence of a small per cent of water.

Bulkhead—A partition or form used for shutting off a part of given space.

Bumpometer—A straight edge equipped with wheels and an elecric signaling device for testing the smoothness of pavements.

Buttress—A vertical projecting piece of masonry built in front of a wall to strengthen it.

Camber—The rise of the center of a bridge or structural member above a straight line through its ends.

Catch Basin—A receptacle for diverting surface water to an underdrain, having at its base a sediment bowl.

Caulk—To fill seams or joints in such manner as to prevent leaking.

Cement Gun—A trade name applied to an apparatus used for the placing of mortar under pressure, the characteristics being that the mortar is forced dry to the nozzle, hydration taking place at the nozzle and coincident with the application.

Centers and Centering (for arches)—False work for an arch.

Chips—Small angular fragments of stone or slag containing no dust.

C. O.—Cold Oil—Asphalt fluxed with 22 per cent to 30 per cent of naphtha, so that it can be applied cold.

Cofferdam—An enclosure built in the water, and then pumped dry, so as to permit masonry or other work to be carried on inside of it.

Consistency—The degree of solidity or fluidity of materials.

Coping—A top course of stone or concrete, generally slightly projecting, to shelter the masonry from the weather, or to distribute the pressure from exterior loading.

Counterfort—Vertical projections or reinforced masonry built along the back of a wall to strengthen it.

Counter Sink—To cut away material from the edge of a hole in such manner that the head of a screw, rivet or bolt will be flush with the surface.

Creep—A slow, natural, downward movement of loose material on hillsides.

Creosoting Oil—Tar distillates, tars and mixtures of tars with tar distillates which are used by a process of impregnation in the preservation of wood. Note: This term was originally confined to the heavier coal-tar distillates carrying a large proportion of the creosols which were present in the tar before distillation.

Crown—Highest point on cross-section, usually the center.

Crown (of an Arch)—The highest point of an arch rib or ring.

Crusher Run—The total unscreened product of a stone crusher.

C. T.—Cold Tar—Tar fluxed with some of the lighter distillates, so that it can be applied cold.

Culvert—Roadway structure of a span of more than one foot, designed to support a superimposed load of earth or other filling material.

Cut Back Products—Petroleum, or tar residuums, which have been fluxed with distillates.

Dead Load—The weight of structure, together with fill, pavement and other permanent loads.

Deformed Bar—A steel bar for reinforcing concrete and which has projections on its surface in order to secure a mechanical bond between the concrete and the steel. These projections are formed either by passing the bar through specially shaped rolls or by twisting the bar.

Dowels—Metal bars used to connect two sections of masonry.

Drift Punch—A smooth, tapered pin for bringing rivet holes into alignment.

Drop Forged—Forged between dies by means of a drop hammer or drop press.

Drop Hammer—(Pile Driving) One which is raised by means of a rope or cable and then allowed to drop.

Dry Masonry—Masonry laid up without mortar.

Ductility—The physical characteristics of a material which permits it to be distorted without breaking.

Easement or Easement Deed—(Right-of-way) A grant of an indefinite right of use, for a certain purpose, at the will of the grantee.

Emulsion—A combination of water and oily material made soluble through the action of a saponifying or other agent.

End Box—Gussets, shoe cover plates and other details at shoe pins of truss spans.

Extrados—The outer or convex surface of an arch.

False Work—Temporary support for a structure during construction.

Field Coat—A coat of paint put on steel or other material after or just prior to erection.

Fillet—A concave junction or molding of two surfaces.

Flange—A projecting edge or rim.

Flash Point—That degree of temperature at which a given substance gives off vapor in sufficient quantity to flash.

Flow Line—(1) The bottom of a steam bed. (2) The lowest point of the inside diameter of a pipe.

Flux—Bitumens, generally liquid, used in combination with harder bitumens for the purpose of softening the latter.

Gram—.0022 of a pound.

Gunite—Mortar placed with a cement gun.

Gutter—The artificially surfaced and generally shallow waterway, provided usually at the sides of the roadway for carrying surface drainage. Occasionally used synonymously with ditch, but incorrectly so, as gutters are always paved or otherwise surfaced, and ditches are not.

Gusset Plate—A plate connecting two or more structural members not in the same straight line.

Hanger (Through Arch)—A vertical tension member transmitting the load to the arch rib.

Hardpan—A soil which may be either (1) a very dense subsoil, such as tough clay; (2) a cemented layer in the soil, where ground waters have precipitated a local binder of silica carbonates, iron oxides, etc.; or (3) dense clayey glacial drift.

Header (1)—A curb placed across the road at the end of a pavement and set flush with the top of the pavement to hold the end of the pavement in place. (2) A stone or brick laid with its largest dimension at right angles to the face of the masonry.

H. O.—Hot Oil—Asphalt of such consistency that it must be heated above 225 deg. F. to be applied effectively.

H. T.—Hot Tar—Tar of such consistency that it must be heated above 175 deg. F. to be applied effectively.

Intrados—The inner or concave surface of an arch.

Invert—That part of a pipe or sewer below the spring line.

Jute—A fibrous, vegetable substance used for caulking.

Knapping—Breaking up coarse aggregate by means of hammers or sledges.

Laitance—A thin layer of inert material which collects on the surface of concrete when it is deposited and forms a light chalky crust on hardening.

Leads—The upright parallel members of a pile driver which support the sheaves used to hoist the hammer and piles, and which guide the hammer in its movement.

Macadam—A road crust composed of stone or similar material broken into irregular angular fragments compacted together so as to be interlocked and mechanically bound to the utmost possible extent.

Mastic—A mixture of bituminous material and fine mineral matter suitably made, for use in highway construction and for application in a heated condition.

Mat—A bituminous layer of appreciable thickness, generally formed on top of a pavement by the application of one or more coats of bituminous material with gravel or stone chips added.

Mix or Mixture—Sometimes used to denote the proportions of the several parts of concrete.

M. T.—Medium Tar—Tar of such consistency that it must be above 100 deg. F. to be applied effectively.

Natural Bed—The surface of a stone parallel to its stratifications.

Ogee—A moulding on the shape of an S.

Oil Asphalt—Asphalt manufactured directly from petroleum.

Ordinate—The perpendicular distance from a point on the tangent to a point on the curve.

Organic—The product of animal or vegetable life.

Penetration—The consistency of a bituminous material expressed as the distance that a standard needle vertically penetrates a sample of the material under known conditions of loading, time and temperature.

Penetration Method—The method of constructing a bituminous macadam pavement by pouring or grouting the bituminous material into the upper course of the road material before the binding of the latter has been completed.

Pile—A member usually driven or jetted into the ground and deriving its support from the underlying strata, and by the friction of the ground on its surface.

Pipe Cap—A metal and wood cap placed over the head of a pile to protect it while driving.

Plumbs—Stones or boulders of a volume of more than one cubic foot, incorporated in concrete masonry.

Pointing—Filling joints or defects in the face of a masonry structure.

Pot-Hole—A hole extending below the wearing course.

Precast Concrete—Concrete which is cast into forms and then hoisted and set in place.

Profilometer—A machine for recording the irregularities of the surface of the pavement.

Quartering—Dividing a sample of material by thoroughly mixing it and striking it off into four parts. The one-fourth part is again mixed and quartered and so on until the volume is the amount required for testing.

Rip Rap—Rough stone of various sizes placed compactly or irregularly to prevent scour of water.

Road—A highway outside of an urban district.

Road Metal—Broken stone, gravel, slag or similar material used in road and pavement construction and maintenance.

Road Bed—The portion of the roadway extending from shoulder line to shoulder line; in other words, the subgrade and shoulders considered as a unit.

Rock Asphalt—Sandstone or limestone naturally impregnated with asphalt.

Rocker—A casting supporting the free end of a span, allowing expansion by a rocking motion of the casting.

Rubble—Field stone or rough stone as it comes from the quarry. When it is of a large or massive size it is termed block rubble.

Scarify—To loosen or disturb superficially.

Screen—In laboratory work, an apparatus, in which the apertures are circular, for separating sizes of material.

Screenings—Broken rock, including the dust, of a size that will pass through one-half to a three-quarter in. screen, depending upon the character of the stone.

Seal Coat—A final superficial application of bituminous material during construction to a bituminous pavement.

Seepage—Quiet emergence of water along some rather extensive line or surface, as contrasted with a spring whose water emerges from a single spot.

Sheet Piles—Piles driven in close contact in order to provide a tight wall, to prevent leakage of water and soft materials; or driven to resist the lateral pressure of adjacent ground.

Shoe—(1) A metal protection for the foot or end of a pile. (2) That portion of a superstructure resting directly upon the abutment.

Shoulder—See Berm.

Skew—The angle which the center line of a bridge makes with a line normal to the center line of the roadway.

Slope Wall—A wall to protect the slope of an embankment or cut.

Slope Stakes—Stakes set to indicate the top or bottom of a slope.

Slump—The vertical distance which concrete subsides from its moulded shape when tested for consistency by the standard method.

Snow Fence—A structure erected for the purpose of forming artificial eddies on the windward side of a cut at sufficient distance away to cause snow to deposit between the snow fence and the cut.

Soffit—The under or concave side of an arch.

Spall—A chip or small piece of stone from a large block.

Span—The distance between the faces of the abutments of a bridge on the center line of the roadway.

Springing Line—The line in which the soffit of an arch meets the skewback.

Stretcher—A stone which has its greatest length parallel to the face of the wall.

Subgrade—The upper surface of the native foundation on which is placed the road metal or the artificial foundation, in case the latter is provided.

Subsoil—The bed of earth immediately beneath the surface soil.

Sump—A well into which water may be conducted by ditches to drain other portions of the work.

Surface Treatment—Treating the finished surface of a roadway with bituminous or other material.

Tailings—Stones, which, after going through the crusher, do not pass through the largest openings of the screen.

Tar—Bitumen which yields pitch upon fractional distillation and which is produced as a distillate by the destructive distillation of bitumens, pyro-bitumens, or organic material.

Telford—An artificial foundation formed of stone about eight inches thick laid by hand and closely packed together.

Templet—A gauge, pattern or form for testing a surface.

Toughness—The property of resistance to breaking by impact.

Tremie—A pipe or conduit having a valve or door on the bottom for placing concrete under water.

Viscosity—The measure of the resistance to flow of a bituminous material, usually stated as the time of flow of a given amount of the material through a given orifice.

Volatile—Applied to those fractions of bituminous materials which will evaporate at elitemperatures.

Wearing Surface or Course—The course of the pavement exposed to traffic.

Weep Hole—A hole through an abutment or retaining wall for drainage.

Wing Wall—An extension of an abutment wall to retain the adjacent earth.

Progressive Operations in Design

Because of the magnitude of the road construction industry the engineering work has necessarily become highly systematized for greatest efficiency. It is quite a long road from initial survey to completed plan. There must of necessity be certain limitations placed on the degree of accuracy required in the various processes. These are nicely explained in the instructions to draftsmen and designers issued by the North Dakota and The Virvinia State Highway Commissions.

The North Dakota instructions state:

1. Transit man checks transit notes.
2. Levelman checks level notes.
3. Chief of party checks all notes.
4. Designer checks:

a. Platting of profile and cross section elevation.

b. Plat of transit notes, bench marks, culverts and classification notes, clearing and grubbing, plowing and harrowing notes.

c. Tentative grade line for maximum and ruling grades, for culvert cover, for height of fills, for approximate balance of quantities.

d. Per cent of grades.

e. Grade elevations for stations at which cross sections were taken.

f. Template on cross section sheet, selection of template, elevation.

g. Areas of one in twenty cross sections.

h. Computation in grading quantities, computation and additions.

i. Clearing and grubbing and clearing and grubbing quantities, computation and addition.

j. Plowing and harrowing, and plowing and harrowing quantities, computation and addition.

k. Drainage structures, adequacy and economy of drainage, invert elevations, drainage structure quantities, computation and addition.

l. Surfacing and surfacing quantities, computation and addition.

m. Mile summaries all items, additions.

n. Project summary, all items, against summation of mile summaries and against total of yardage quantity sheets.

o. Compares project summary of quantities with the reconnaissance estimate.

5. Assistant designer checks areas of cross sections.

6. Chief Draftsman checks:

a. Profile, ruling and maximum grades, height of fill, culvert invert.

b. Plan stationing, bearings, topography, culverts, notes on classification, clearing and grubbing, and plowing and harrowing.

c. Inspects the finished plans for standard and neatness of execution.

The Virginia instructions state:

1. Grade elevations shall be figured to the nearest .10 ft. for all classes of roads.

2. All odd gradients shall be carried to as many decimal places as may be necessary in order that the accumulated error in any one grade may not be more than .01 ft.

3. For excavation and embankment, the end areas shall be carried to the nearest square foot and the volumes carried to the nearest cubic yard.

4. For surfacing, the amount of soil or gravel shall be carried to the nearest cubic yard. For other types, the quantities of surfacing shall be carried to the nearest square yard.

5. In computing both Class "A" and Class "B" concrete for structures, the quantities shall be carried to as many decimal places as are shown on the standards from which unit quantities are obtained, however, the final results shall not be shown beyond two decimal places.

6. Reinforcing steel shall be carried to the nearest pound.

7. Clearing and grubbing shall be carried to two decimal places.

8. All distances shall be carried to two decimal places except the length of project which shall be carried to three places.